



TERRITORY OF PAPUA AND NEW GUINEA

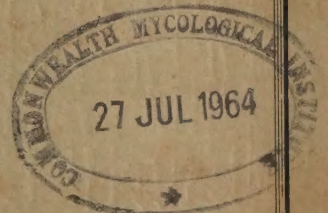
DEPARTMENT OF AGRICULTURE, STOCK
AND FISHERIES

ANNUAL REPORT

1960-61

PORT MORESBY, NOVEMBER, 1963

	N S P	
C	R A M	C
	M M	





TERRITORY OF PAPUA AND NEW GUINEA

DEPARTMENT OF AGRICULTURE, STOCK
AND FISHERIES

ANNUAL REPORT

1960-61

PORT MORESBY, NOVEMBER, 1963



TERRITORY OF PAPUA AND NEW GUINEA

DEPARTMENT OF AGRICULTURE, STOCK
AND FISHERIES

HIS HONOUR THE ADMINISTRATOR,
SIR DONALD CLELAND, C.B.E., O.St.J.,
PORT MORESBY.

Your Honour,

I have the honour to submit herewith the Annual Report of the Department of
Agriculture, Stock and Fisheries for the year ending 30th June, 1961.

1960-61

W. L. CONROY,
Acting Director.

PORT MORESBY, NOVEMBER, 1961

CONTENTS

	PAGE.
THE TERRITORY OF PAPUA AND NEW GUINEA	1
Political	1
Physical	1
THE ECONOMY OF THE TERRITORY	3
Introduction	3
Agricultural Exports	3
Fisheries Exports	6
DEPARTMENT OF AGRICULTURE, STOCK AND FISHERIES	7
Organization	7
DIVISION OF ANIMAL INDUSTRY	9
Veterinary Services	9
Veterinary Research	16
Animal Husbandry	16
Livestock Stations	18
Papuan Lowlands Livestock Station, Moitaka	20
Papuan Highlands Livestock Station, Bisianumu	23
Animal Industry Centre, Three Mile, Lae	24
New Guinea Lowlands Livestock Station, Erap	24
Animal Industry Centre, Goroka	27
Western Highlands Livestock Station, Baiyer River	28
Animal Industry Centre, Kurakakaul	29
Cattle Statistics	30
DIVISION OF PLANT INDUSTRY	31
Lowlands Agricultural Experiment Station, Keravat	31
Cacao	31
Coconut	39
Robusta Coffee (<i>Coffea canephora</i>)	46
Manila Hemp (Abaca)	47
Food Crop Agronomy	48
Highlands Agricultural Experiment Station, Aiyura	53
Coffee (<i>Coffea arabica</i>)	53
Pyrethrum	58
Soil Exhaustion and Rotation Experiments	58
Management Trial—Sweet Potato	58
Pastures	58
Tobacco	58
Fish	58
Agricultural Experiment Station, Epo	59
Rice	59
Abaca (Manila Hemp)	60
Cashew Nut	60
Cotton	60
Castor Bean	60
Coffee (<i>Coffea canephora</i>)	61
Coconut	61
Legumes	61
Leucaena Hybrids	61
Maize	62
Oil Palm	62
Peanut	62
Sisal	62
Sorghum	62
Soy Bean	62
Tobacco	63
Rubber Section, Bisianumu	64
Plant Industry Centre, Bubia	65
Sisal	65
Cacao	66
Pasture Investigations	67
Cotton	68
Maize	68
Castor Bean	69
Lemon Grass	70
Vanilla	71

	PAGE.
Division of Plant Industry—continued.	
Experimental Tea Plantation, Garaina	71
Plant Introduction and Quarantine Station, Laloki	71
Experimental Plots, Yambi	74
Plant Pathology	74
Microbiology	74
Virology	76
General Pathology	78
Economic Entomology	79
Visiting Specialists	80
Card Registers of Insects and Collection	80
Extension	80
Field Trips and Surveys	80
Pests of Economic Crops	80
Biological Control	86
Agricultural Chemistry	87
Soil Analysis	87
Plant Nutrition Studies	89
General and Industrial Investigations	91
Phytochemical Investigations	91
Miscellaneous Analyses	92
Overseas Visitors	92
Soil Survey	93
Western Highlands District	93
Central District	93
Gulf District	93
New Britain District	93
Reconnaissance Surveys	94
Individual Block Inspections	94
DIVISION OF EXTENSION AND MARKETING	95
Principal Types and Methods of Indigenous Agriculture	95
Cultivation Methods and Techniques of the Indigenes	95
Status of Indigenous Agriculture	97
Survey of Indigenous Agriculture	97
Development Plans for Indigenous Agriculture	98
Evaluation of Territory Agriculture	98
Agricultural Training	101
Agricultural Extension Stations	102
Agricultural Extension Centres	102
Agricultural Patrolling and Village Contacts	102
Development of Major Programmes of Rural Organization and Marketing	102
Land Settlement Projects	104
Other Services Provided by the Division of Extension and Marketing	104
DIVISION OF FISHERIES	105
Fisheries Surveys—Marine	105
Freshwater Fisheries	112
Fisheries Establishments	112
Synthetic Netting Materials	113
Highlands Experimental Ponds	113
Bomana Quarantine Pond	113
ADMINISTRATIVE BRANCH	114
STAFF, DEPARTMENT OF AGRICULTURE, STOCK AND FISHERIES AT 30TH JUNE, 1961	116
Headquarters Division	116
Division of Animal Industry	117
Division of Plant Industry	118
Division of Extension and Marketing	121
Division of Fisheries	124
PAPERS PUBLISHED BY OFFICERS OF THE DEPARTMENT 1960-61	125
OTHER PAPERS OF DIRECT RELEVANCE TO THE TERRITORY PUBLISHED IN 1960-61	125



SCALE OF MILES
25 0 25 50 75 100 125 150

TERRITORY OF
PAPUA AND NEW GUINEA

NEW IRELAND

BOUGAINVILLE

Kavieng

Rabaul

Kokopo

Talasea

NEW BRITAIN

Kiefta

Sohano

Manus

MANUS

MADANG

Kar Kar I.

Madang

Saidor

Boana

Lae

Finschhafen

Huan Gulf

Markham R.

MOROBE

Bulolo

Wau

Kairuku

Port Moresby

Sogeri

Kokoda

Popondetta

Abau

Samarai

CENTRAL

GULF

Gulf of Papua

SEPIK

Aitape

Wewak

Sepik R.

Baiyer R.

Ramu R.

Bagia

Wahapi R.

Banz

Goroka

Eastern Highlands

Markham R.

Papua R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

Wahapi R.

WESTERN HIGHLANDS

Mt. Hagen

Mendi

SOUTHERN HIGHLANDS

Western Highlands

Strickland R.

Fly R.

Kikori

Daru

Daru

THE TERRITORY OF PAPUA AND NEW GUINEA.

POLITICAL.

The island of New Guinea and its associated islands are divided politically into three areas. The western part of the mainland is Netherlands New Guinea and the eastern part administered by Australia is further sub-divided into the Territory of Papua, which is Australian territory, and the Territory of New Guinea, which is administered by Australia in trust from the United Nations Organization.

The Territory of Papua comprises the southern portion of the eastern half of the island of New Guinea together with a large number of geographically associated islands, the most important of which are the D'Entrecasteaux group and the Louisiade archipelago.

The Territory of New Guinea consists of the northern part of the eastern half of the main island of New Guinea and the major islands of New Britain, New Ireland, New Hanover, Manus, Buka and Bougainville, together with several hundred smaller islands. The geographical boundaries of the Territory of Papua and New Guinea are shown in Figure 1.

The population of Papua and New Guinea is somewhat less than 2,000,000 people of whom a little more than 500,000 are in Papua. There are large areas, especially in the swampy lowlands of Eastern Papua, with very low population densities. The most populous areas are in the New Guinea highlands where population density exceeds 500 per square mile in limited areas, and the Sepik District.

The basis of the Territory's legislative, administrative and judicial systems is the *Papua and New Guinea Act 1949-60*, of the Commonwealth of Australia, which came into force on 1st July, 1949. The Act provided for the administration of the Territory of Papua in an administrative union with the Trust Territory of New Guinea. The Act, which is administered by the Minister of State for Territories, the Honourable Paul Hasluck, M.P., through the Department of Territories at Canberra, provided for the appointment of an Administrator to administer the government of the Territory on behalf of the Government of the Commonwealth of Australia. The Administrator is assisted by an Administrator's Council of six members over which he presides. The Act also provided for a Legislative Council which, subject to the assent of the Administrator or, in certain cases defined in the Act, of the Governor-General, has full legislative powers in regard to the peace, order and good government of the Territory.

Under the general direction of the Administrator the administrative functions of government are discharged by seventeen Departments, the officers of which are members of the Public Service of the Territory of Papua and New Guinea. The detailed administration of each Department is the responsibility of the departmental head, subject to the direction of the Administrator. Head-quarters of the Administration are located in Port Moresby, Papua.

The Territory is divided into fifteen districts, as shown in Figure 1. Each district is under the control of a District Commissioner, who is responsible for the co-ordination of Departmental activities in his area.

PHYSICAL.

The total area of the Territory of Papua and New Guinea is 183,500 square miles. It lies wholly within the inner tropics between Latitudes 1° and 12° South and Longitudes 141° and 156° East. New Guinea and its associated islands represent the eastern extremity of the great arc of fold mountains which extend through the Himalayas and Malaya into the Pacific. The central cordillera, which is one of the great mountain systems of the world, extends from one end of the mainland to the other, a distance of about 1,500 miles. It reaches heights in excess of 15,000 feet and includes some of the world's most rugged country.

The rainfall is generally moderate to high although strongly monsoonal in many areas, and there are no deserts or very arid zones. Extensive swamps occur in the lowlands. There are major valley systems in the highlands with floors generally around 5,000 feet. These highland valleys have a mild climate with frost occurring at higher altitudes and there is occasional snow on a few of the highest mountain peaks. The climate in the lowlands is typical of the humid tropics.

The physiography, drainage, climate, soils and agriculture of the Territory were discussed in some detail in the 1959-60 Annual Report.

The island of New Guinea and its associated islands are situated in the western Pacific Ocean. The western part of the mainland is bounded by the Indian Ocean and the eastern part by the Pacific Ocean. The island is divided into two main parts, the northern and southern halves, by a large mountain range which runs north-south through the center of the island. The northern half is generally lower and flatter, while the southern half is generally higher and more mountainous.

The Territory of Papua consists of the northern half of the island of New Guinea, together with a large number of islands in the surrounding waters. The southern half of the island is the Territory of New Guinea, which is administered by the Australian Government.

The Territory of New Guinea consists of the northern half of the island of New Guinea, together with a large number of islands in the surrounding waters. The southern half of the island is the Territory of New Guinea, which is administered by the Australian Government.

The population of Papua and New Guinea is estimated to be about 2,000,000 people. The population is distributed unevenly, with the highest concentrations in the lowlands of the eastern half of the island. The population is made up of many different ethnic groups, with the most numerous being the Melanesians.

The form of the Territory's government is determined by the Papua New Guinea Constitution. The Constitution provides for a system of government in which the executive power is vested in the Governor-General, who is appointed by the Queen on the advice of the Prime Minister. The legislative power is vested in the National Parliament, which consists of the House of Representatives and the Senate. The House of Representatives is elected by the people, while the Senate is appointed by the Governor-General on the advice of the Prime Minister.

Under the general direction of the Administrator, the administrative functions of the Territory are carried out by the various departments. The departments are responsible for the day-to-day running of the Territory, and are headed by the Administrator, who is the highest official in the Territory.

The Territory is divided into three districts, as shown in Figure 1. Each district is headed by a District Commissioner, who is responsible for the administration of the district.

PHYSICAL

The land area of the Territory of Papua and New Guinea is 462,000 square miles. It lies within the tropics, between latitudes 1° and 12° south and longitudes 141° and 156° east. The island is bounded by the Indian Ocean to the west and the Pacific Ocean to the east. The island is divided into two main parts, the northern and southern halves, by a large mountain range which runs north-south through the center of the island. The northern half is generally lower and flatter, while the southern half is generally higher and more mountainous.

THE ECONOMY OF THE TERRITORY.

INTRODUCTION.

Present knowledge of the resources of the Territory of Papua and New Guinea suggests that its development will depend to a major degree upon an expanding agriculture to supply basic foodstuffs for a growing population and to earn foreign exchange from exports. With this accepted basis for economic advancement, the Department of Agriculture, Stock and Fisheries has continued to develop its programmes for widening and strengthening the agricultural sector of the economy.

The nature of indigenous subsistence agriculture makes measurement of its output difficult, but the commencement of field work on the F.A.O. Survey of Indigenous Agriculture during the year has been the first positive step in developing a basic framework for assessment. The export sector of agricultural production has continued to expand, and native participation in cash cropping has been further encouraged. The proportion of the main export crops produced by indigenous farmers in 1960-61 was 25 per cent. for copra and other coconut products, 25 per cent. for cocoa, 33 per cent. for coffee and 15 per cent. for peanuts.

The Territory economy has the same general characteristics as that of most developing countries. Agriculture is the principal economic activity; the export sector is only a small part of the total agriculture and has long been dominated by one product, although fairly rapid progress is being made towards diversity.

Over the last ten years, the value of imports has exceeded export earnings and only in 1952-53 did the two approach a balance. The position is shown in Table 1.

TABLE 1.—TOTAL IMPORTS AND EXPORTS¹—VALUE (£'000) 1951-52 TO 1960-61.

Year.	Imports.	Exports. ¹	Excess of Imports.	Exports as Percentage of Imports.
1951-52	12,738.5	9,371.8	3,366.7	73.6
1952-53	10,994.4	10,473.0	521.4	95.2
1953-54	13,788.0	11,217.3	2,570.7	81.3
1954-55	17,048.3	12,106.8	4,941.5	71.0
1955-56	19,418.0	12,186.0	7,232.0	62.7
1956-57	19,754.9	11,810.3	7,944.6	59.8
1957-58	20,396.3	10,898.2	9,498.1	53.4
1958-59	20,263.0	14,467.7	5,795.7	71.4
1959-60	21,031.9	17,103.9	3,928.0	81.3
1960-61	26,738.4	14,256.7	12,481.7	53.3

¹ Excluding re-exports.

Because of falling export prices for the main products during 1960-61, the excess value of imports over exports reached approximately £12,500,000 and earnings from exports were only 53 per cent. of the value of imports.

AGRICULTURAL EXPORTS.

Agricultural commodities continued to dominate the export picture and in 1960-61 85 per cent. of total export earnings came from these products, as shown in Table 2, the percentage remaining the same as in the previous year.

TABLE 2.—VALUE OF PRINCIPAL EXPORTS¹ AS A PERCENTAGE OF TOTAL EXPORT INCOME IN SELECTED YEARS.

Commodity.	1951-52.		1955-56.		1958-59.		1959-60.		1960-61.	
	£'000.	Per cent.	£'000.	Per cent.	£'000.	Per cent.	£'000.	Per cent.	£'000.	Per cent.
Coconut Products—										
Desiccated Coconut	236	63	..	63	..	60	..	60	..	54
Copra	5,720		6,186		5,754		6,126		5,113	
Coconut Oil ..	..		1,327		2,754		3,814		2,361	
Copra Cake and Meal	..		131		179		346		284	
Rubber	1,244	13	1,387	11	1,152	8	1,500	9	1,292	9
Cocoa	148	2	361	3	1,492	10	1,671	10	1,666	12
Coffee	10	..	94	1	456	3	717	4	1,106	8
Peanuts	1	..	23	..	297	2	284	2	280	2
Total Agriculture ²	7,359	78	9,509	78	12,084	83	14,458	85	12,102	85
Shell—										
Green Snail ..	35	1	81	1	10	1	13	1	8	..
Mother of Pearl ..	..		2		2		3		2	
Trochus	62		36		82		93		44	
Other Non-agricultural ³	1,916	21	2,558	21	2,290	16	2,537	14	2,101	15
Total	9,372	100	12,186	100	14,468	100	17,104	100	14,257	100

¹ Includes re-exports.² Excludes passionfruit pulp and juice.³ Includes gold.

Over the last ten years, agricultural products have contributed an average of about 80 per cent. of the export income. Coconut products, within which group copra is the most important, have remained the principal export. Cocoa and coffee have increased their contribution steadily, while earnings from rubber have barely held their place.

COCONUT PRODUCTS.

Exports of coconut products over the last decade are shown in Table 3 and Figure 2.

TABLE 3.—QUANTITIES OF PRINCIPAL EXPORTS (IN TONS) IN SELECTED YEARS.

Commodity.	1951-52.	1955-56.	1958-59.	1959-60.	1960-61.
Coconut Products—					
Desiccated Coconut	1,469	..	..	..	..
Copra	76,903	80,185	64,009	65,396	76,524
Coconut Oil	..	10,331	21,541	25,526	20,429
Copra Cake and Meal	..	6,127	7,947	12,269	10,290
Rubber	2,850	3,793	4,380	4,399	4,373
Cocoa Beans	477	1,290	4,253	5,870	7,291
Coffee Beans	34	171	969	1,488	2,294
Peanuts	6	172	1,766	1,897	2,019
Shell—					
Green Snail	244	198	30	33	17
Mother of Pearl	3	15	12	14	5
Trochus	520	754	252	342	239

Exports of copra amounted to 76,524 tons in 1960-61, an increase of 11,228 tons over the previous year. However, because of falling world prices, value fell to £5,113,000, a decrease of £1,013,000. Figure 3 shows movements in the value of coconut products over the last ten years.

From 1951-52 to 1960-61, a notable change occurred in the composition of the commodities which make up the group of coconut products. At the commencement of the decade, copra exports accounted for 61 per cent. of total export income, but by 1960-61 this



Figure 2—Coconut Products (volume).

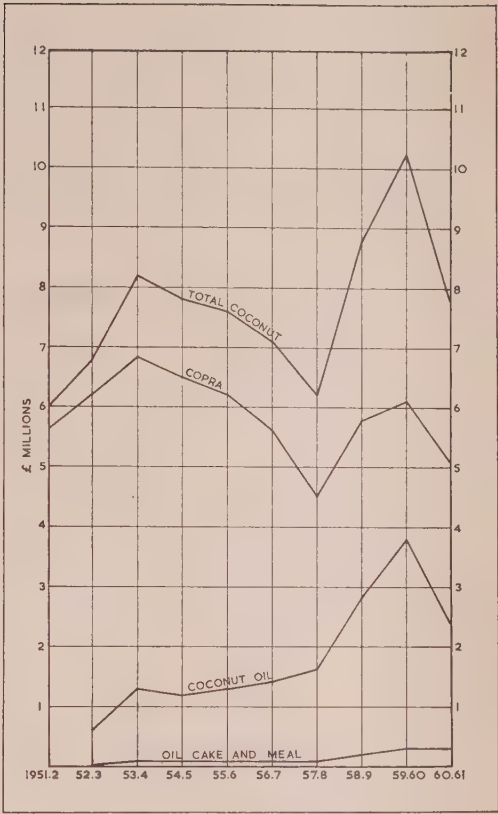


Figure 3—Coconut products (value).

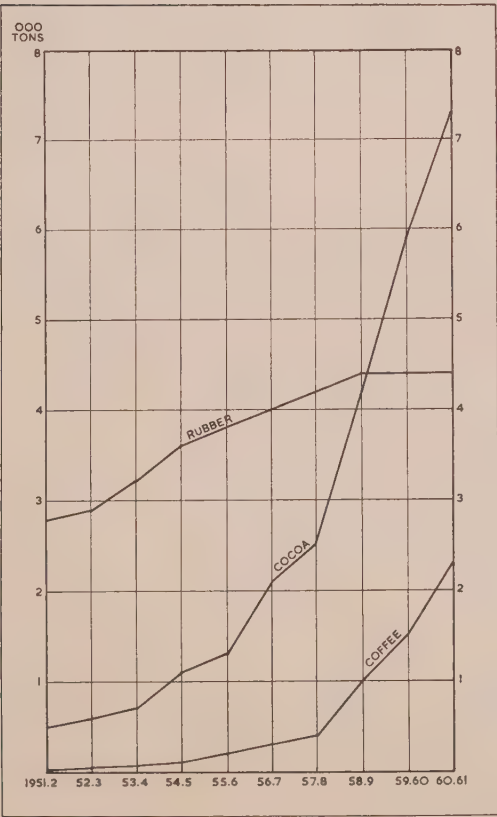


Figure 4—Cocoa, Coffee, rubber (volume).

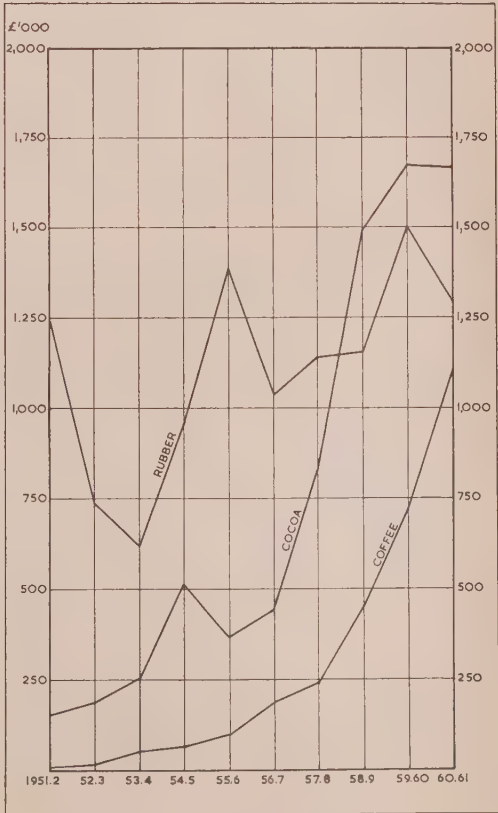


Figure 5—Cocoa, Coffee, Rubber (value).

Exports of leading agricultural products from the Territory of Papua and New Guinea.

figure had declined to 36 per cent. Desiccated coconut was a significant contributor to export earnings in 1951-52, but owing to difficulty in meeting health regulations in Australia, the principal market, this product has ceased to be manufactured in the Territory.

In 1953, a copra crushing mill was established at Toboi, near Rabaul, and since then coconut oil has become an important export. Production has increased from 3,600 tons in 1952-53 to 20,429 tons in 1960-61; in 1959-60, shipments reached the record figure of 25,526 tons. Exports of coconut oil were valued at £2,361,000 in 1960-61, making up 16.5 per cent. of total export income.

Export values for coconut products are shown in Table 2, and average prices per ton are shown in Table 4.

TABLE 4.—AVERAGE ANNUAL PRICES (£ PER TON) PRINCIPAL COMMODITIES—
1956-57 TO 1960-61.

Commodity.	1956-57.	1957-58.	1958-59.	1959-60.	1960-61.
Copra	71.5	63.0	89.9	93.7	66.8
Coconut Oil	116.0	99.5	126.8	149.4	115.5
Oil Cake and Meal	20.6	20.2	22.5	28.2	27.6
Coffee	669.5	584.5	470.6	481.9	482.1
Cocoa	217.5	320.0	350.7	284.7	228.5
Rubber	289.5	261.7	262.9	341.0	295.5
Peanuts	169.1	150.4	168.1	150.0	138.7

The average value of copra per ton in 1960-61 was £66.8, while the corresponding figure for the previous year was £93.7. Coconut oil values also fell steeply, the average being £115.5 per ton compared with £149.4 in 1959-60. Oil cake and meal fell only slightly from £28.2 to £27.6 per ton.

COCOA.

Cocoa beans reached second position in value in the list of exports. The rapid increase in production over the last ten years is shown in Figure 4 and Table 3. In 1951-52, exports were 477 tons, but by 1960-61 reached 7,291 tons. Since 1958-59, the volume of cocoa exports has exceeded that of rubber. In terms of value, cocoa bean shipments, amounting to £1,666,000 in 1960-61, accounted for about 12 per cent. of export earnings (*see* Table 2 and Figure 5).

The average export value of cocoa beans fell to £228.5 per ton compared with £284.7 per ton in the previous year.

Production of cocoa will continue to expand in the future. Most of the plantings are in the Territory of New Guinea, which provided 99 per cent. of exports in 1960-61 (*see* Table 5) but new areas are coming into bearing on volcanic soils in Northern Papua.

TABLE 5.—COMPARISON OF TERRITORY OF PAPUA AND TERRITORY OF NEW GUINEA
EXPORTS (IN TONS), 1958-59 TO 1960-61.

Commodity.	Territory of Papua.			Territory of New Guinea.			New Guinea Exports as Percentage of Total (3-year Average).
	1958-59.	1959-60.	1960-61.	1958-59.	1959-60.	1960-61.	
Copra	14,681	14,649	15,578	49,328	50,747	60,946	78
Coconut Oil	..	..	..	21,541	25,526	20,429	100
Copra Cake and Meal	..	..	..	7,947	12,269	10,290	100
Rubber	4,380	4,399	4,373	..	..	..	0
Cocoa Beans	71	68	121	4,182	5,802	7,170	99
Coffee Beans	19	25	31	950	1,463	2,263	98
Peanuts	63	53	12	1,703	1,844	2,007	98

COFFEE.

Only small quantities of coffee were shipped from the Territory pre-war, but the opening up of the Eastern and Western Highlands in the post-war period resulted in the widespread cultivation of Arabica coffee. This development was stimulated by high world prices in the early post-war years.

At the present time practically all the coffee exported is Arabica, with some small parcels of Robusta. Shipments have increased from 34 tons in 1951-52, to 2,294 tons in 1960-61 (see Table 3 and Figure 4). Ninety-eight per cent. came from the Territory of New Guinea.

The value of coffee exports was £1,106,000 in 1960-61, and made up about 8 per cent. of total export income. The average export price at £482.1 per ton remained about the same as in 1959-60.

RUBBER.

Pre-war annual exports of rubber averaged less than 2,000 tons, but since the end of the war, exports have steadily increased to 4,373 tons in 1960-61, as shown in Table 3 and Figure 4. These exports were valued at £1,292,000 and made up 9 per cent. of total export income (see Table 2). The increase in rubber exports has not been as rapid as with the other principal export crops, having risen in the ten years to 1960-61 from 2,800 tons to 4,373 tons. All rubber exports came from Papua.

During 1960-61, the average export value for rubber fell to £295.5 per ton from £341.0 per ton in the previous year.

Present rubber trees are progressively being replaced with new high yielding grafted clones or clonal seedlings so that production could be doubled from the same acreage. There is, moreover, a concurrent increase in acreage.

OTHER AGRICULTURAL EXPORTS.

The other principal agricultural commodities exported from the Territory are peanuts and passionfruit pulp and juice. Shipments of the former amounted to 2,019 tons in 1960-61 (Table 3), and were valued at £280,000 (Table 2). In common with other agricultural products, the average export price fell, declining to £138.7 per ton.

Passionfruit pulp and juice shipments during 1960-61 reached 305,000 lb. valued at £56,949. Exports were well below those of the previous year when the total was 496,000 lb., valued at £94,002.

FISHERIES EXPORTS.

No significant quantities of edible marine products are exported from the Territory as production is consumed internally. Shipments of shell and crocodile skins occur each year.

Three types of shell are exported from the Territory, viz., trochus, green snail, and pearl shell. Their values are shown in Table 2. There is a falling world demand for these products because of the development of synthetic substitutes.

TROCHUS.

The first five years of the decade 1951-52 to 1960-61 were characterized by a strong demand for trochus shell. Output responded to demand, and although it rose from 500 to 800 tons, values increased more rapidly from £61,000 at the commencement of the period to £258,200 in 1955-56. Since that year, world prices have declined and exports of trochus have dwindled. In 1960-61, shipments amounted to 240 tons valued at £44,384, while corresponding figures were 340 tons valued at £92,621 in the previous year.

GREEN SNAIL SHELL.

From 1951-52 to 1955-56, exports of green snail shell remained at about 200 tons, but owing to rising world prices, the value increased from £34,600 at the commencement of this period to £80,600 in 1955-56. Since that year, however, output has fallen, declining in 1960-61 to about 18 tons, valued at £8,078.

PEARL SHELL.

Exports of pearl shell have remained small throughout the last decade. Value in 1960-61 was £1,521 compared with £3,565 in the preceding year. The pearl oyster beds of the Territory are not particularly suitable for commercial fishing as they have a sharply shelving bottom and are susceptible to strong tidal influence.

CROCODILE SKINS.

Export value of crocodile skins rose sharply during 1960-61, reaching £128,157, compared with £65,880 in the previous year. The principal hunting areas were the two largest rivers, the Fly and the Sepik, and their tributaries.

DEPARTMENT OF AGRICULTURE, STOCK AND FISHERIES.

ORGANIZATION.

The Department of Agriculture, Stock and Fisheries has its head-quarters at Port Moresby under the direct control of the Director, operating through the Administrative Officer, who is in charge of the administrative and clerical section, and the Chiefs of the four technical divisions, which are: the Division of Animal Industry, the Division of Plant Industry, the Division of Extension and Marketing and the Division of Fisheries.

For the purposes of the Department of Agriculture, the Territory of Papua and New Guinea is divided into three regions, namely, Papua, the New Guinea mainland, and the New Guinea islands. A semi-autonomous organization operates in each of these regions under the control of a Regional Agricultural Officer who is responsible for directing the activities of the Division of Extension and Marketing and for co-ordinating the activities of the other Divisions represented in his region. The Division of Extension and Marketing is the only one represented in all districts, and the District Agricultural Officer and his sub-district staff may be required to carry out agency functions for other Divisions as may be appropriate.

The Division of Animal Industry is responsible for research and services with livestock throughout the Territory. The principal types of livestock are British breeds of cattle or more commonly in the lowlands British breeds with an infusion of Brahman blood, owned mainly by expatriates, and pigs and poultry owned mainly by the indigenous inhabitants. The Division operates Experiment Stations where it carries out research and breeds livestock for distribution. There are supporting laboratories with modern equipment to handle all aspects of parasitology, pathology and bacteriology.

The main functions and activities of the Division are as follows:

- (i) The promulgation and administration of animal quarantine legislation.
- (ii) The maintenance of quarantine programmes and supervision over internal and external stock movements.
- (iii) The provision of clinical and advisory veterinary services to stock owners.
- (iv) The planning and conduct of programmes of disease and pest eradication and control.
- (v) Investigations on animal pest and disease problems.
- (vi) Selection and breeding of stock adapted to Territory environments.
- (vii) Services and research in animal husbandry.

The Division of Plant Industry is responsible for research and investigations into all aspects of agriculture and the provision of technical services to the Department and the general public. The specialist sections of the Department of Agriculture, Stock and Fisheries, with the exception of those engaged in livestock research, are attached to the Division of Plant Industry, which also operates Experiment Stations in representative environments throughout the Territory. The main laboratories are in Port Moresby but there are supporting laboratories at selected field stations. The Division is divided into sections each under its own section head.

The main functions and activities of the Division are as follows:

- (i) The promulgation and administration of legislation concerned with plant quarantine and the control of pests, diseases and noxious weeds.
- (ii) Plant introduction and testing of new crops and new varieties of established economic species.
- (iii) Crop improvement and agronomic experiments with all crops grown in the Territory.
- (iv) Production of high grade seed and planting material.
- (v) Investigation of farming systems.

- (vi) Research on crop processing methods.
- (vii) Design and operation of model crop processing facilities and testing of new processing machinery.
- (viii) Soil and land use surveys.
- (ix) Research and services in plant pathology.
- (x) Research and services in economic entomology.
- (xi) Chemical and biochemical services and research.

The Division of Extension and Marketing is responsible for extending to producers, both expatriate and indigenous, the results of investigations carried out by the other Divisions of the Department, and for assisting these producers to apply better techniques to the production, processing and marketing of their crops. The Division also plays a very important role in stimulating and assisting the production of cash crops by indigenous growers who previously had no cash income. Because of the great predominance numerically of indigenous agriculturists, the main emphasis falls on extension and marketing services to this section of the community.

The main functions of the Division are as follows:

- (i) Agricultural patrolling and village contacts to encourage indigenous landholders to adopt improved methods of production with subsistence and cash crops.
- (ii) Distribution of planting material of subsistence and cash crops.
- (iii) Agricultural training up to Agricultural College level.
- (iv) Maintenance of Extension Stations and Centres for—
 - (a) training of lower level intermediaries;
 - (b) demonstration of crop husbandry and processing techniques;
 - (c) local experimentation and adaptability trials;
 - (d) seed production, especially the production of pure seed of crops of local importance.
- (v) Promotion of improved types of rural organizations.
- (vi) Supervision of processing of economic crops and operation of central processing facilities where required.
- (vii) Assistance with the marketing of agricultural produce where satisfactory normal marketing channels are not available.
- (viii) Operation of district mechanization services and area workshops.
- (ix) Produce inspection services.

The Division of Fisheries is responsible for all fishery investigations in the Territory. At the developmental stage its primary functions are the assessment of sea fishery resources and the promotion of commercial fishing together with the investigation of pond fisheries for inland areas. The Division operates a research vessel engaged primarily in testing potential trawling grounds and several smaller auxiliary vessels.

The main functions of the Division of Fisheries are as follows:

- (i) The promulgation and administration of fisheries legislation.
- (ii) The introduction of improved fishing techniques to indigenous fishermen and the distribution of fishing gear.
- (iii) The training of fishermen ashore and afloat in all aspects of fishing.
- (iv) The encouragement of the indigenous people to organize their activities and increase their consumption and trade in fish.
- (v) Investigation of potential fishing grounds and the encouragement of commercial fishing where this does not conflict with subsistence requirements.
- (vi) Promotion of fresh water fish production.
- (vii) Investigations into economic and marketing aspects of the fishing industry.
- (viii) Institution of a fisheries inspection system.

DIVISION OF ANIMAL INDUSTRY.

INTRODUCTION.

Good progress was made in the disease eradication programmes during 1960–61. The New Guinea Highlands which have a major potential for cattle production became tick free and holdings under treatment were reduced in other areas. Similar progress was made in the Tuberculosis and Brucellosis eradication campaigns.

Native cattle projects were extended and increased cattle importations were made by private interests. Plans were also approved for the construction of a central abattoir at Lae, which is expected to have a strongly stimulating effect on the development and expansion of the cattle industry, especially in the Markham Valley.

Good progress was made in building up the numbers of pure Brahman cattle and fifteen Brahman cross yearling bulls with a minimum of half Brahman blood were sold to private cattle interests during the year. However, poor calving percentages limited progress in the Brahman-Africander cross breeding programme.

VETERINARY SERVICES.

DISEASE ERADICATION.

CATTLE TICK (*Boophilus microplus*).

The Division has a policy of ultimate eradication of cattle tick from the whole of the Territory. Success has been achieved in some areas while special difficulties have prevented eradication in others.

Standard eradication spraying was carried out on a weekly basis with two insecticides—D.D.T. and Diazinon—used alternately, each for an eight-week period. Treatments were carried out weekly for three months and then at two-weekly intervals until eighteen months after the last sighting of tick. All treatments were carried out under the supervision of a Departmental Stock Inspector with the owner responsible for full musters of his stock.

Progress this year has been encouraging, with only one reinfestation, the Highlands now tick free and the holdings under treatment reduced from 29 last year to 17 this year. District reports are given below.

CENTRAL DISTRICT.

The three-weekly control spraying programme continued in the lowland areas where the presence of deer and wild horses caused a breakdown following the completion of eradication sprayings in 1958–59. With this programme, ticks were seen only in occasional light infestations.

The Sogeri area has remained cattle tick free.

MOROBE DISTRICT.

The eradication programme progressed satisfactorily, sprayings being completed on all properties involved. The quarantine was lifted on one of the properties on which sprayings were completed the previous year. No cattle tick were sighted in this district during the year.

NEW BRITAIN DISTRICT.

The infestation discovered in May, 1960, was subjected to eradication measures and the spraying programme has continued, the animals being concentrated into one herd. Similar measures were applied to a further outbreak on another property, involving seven cattle and one horse. The source of the infestations has not been determined.

HIGHLANDS DISTRICTS (EASTERN, WESTERN AND SOUTHERN).

Inspections of the two properties on which the eradication spraying programme was completed in 1959–60 showed that they had remained clean and the quarantine on the properties was lifted. The Highlands Districts are now tick free.

MADANG DISTRICT.

The spraying programmes of thirteen of the properties in the immediate vicinity of Madang were completed while the three properties on which a reinfestation occurred in 1959–60, together with a small group of Native-owned cattle, remain under treatment. Regular inspections on the properties where spraying is completed have shown no reinfestations to date.

SUMMARY.

The results in all districts are summarized in Table 6.

TABLE 6.—RESULTS OF THE CATTLE TICK ERADICATION PROGRAMME.

District.				Cattle Treated Each Week.	Horses and Donkeys.	Holdings under Treatment.	Holdings under Inspection.	Holdings Reinfested.
Central ¹	..	..	..	1,890	107	9	0	0
Morobe	..	..	..	56	17	2	2	0
New Britain	..	..	..	102	8	2	0	1
Highlands	..	..	..	0	0	0	2	0
Madang	..	..	..	493 ²	10	4	13	0
Total	..	..	..	2,541	142	17	17	1

¹ Control treatments each three weeks.

² Including 20 buffalo.

TUBERCULOSIS.

Testing was maintained wherever Veterinary Officers were stationed, and in Madang District by a visiting Veterinary Officer. Plate I shows a Veterinary Officer carrying out Tuberculosis tests and Table 7 summarizes results for the current year.

TABLE 7.—RESULTS OF TUBERCULOSIS ERADICATION PROGRAMME.

District.				Animals Tested.	Reactors.	Properties Tested.	Properties Affected.	Per cent. Reactors.
Central	..	..	..	4,398	25	13	4	0.57
Morobe	..	..	..	5,525	12	23	4	0.22
New Britain	..	..	..	274	0	11	0	0
Bougainville	..	..	..	8	0	2	0	0
Highlands	..	..	..	903	0	6	0	0
Madang	..	..	..	977	6	15	2	0.61
Total	..	..	..	12,085	43	70	10	0.36

Eradication progressed satisfactorily in most districts where Veterinary Officers were permanently stationed. The reinfection in the Central District has not been traced to its source but testing showed no reactors in the latter part of the year. Similarly, reactors in the Morobe District were reduced significantly and the overall picture was an improvement on that of the previous year.

BRUCELLOSIS.

Annual check tests for this disease were maintained as well as the repeated testing of affected properties to eliminate reactors. Results are summarized in Table 8.

TABLE 8.—RESULTS OF BRUCELLOSIS ERADICATION CAMPAIGN.

District.				Sera Tested.	Reactors.	Properties Tested.	Properties Affected.	Per cent. Reactors.
Central	..	..	..	2,149	8	12	1	0.37
Northern	..	..	..	358	0	1	0	0
Morobe	..	..	..	5,168	12	24	1	0.23
New Britain	..	..	..	650	0	12	0	0
Highlands	..	..	..	556	0	2	0	0
Total	..	..	..	8,881	20	51	2	0.23

There was a significant decrease in the number of reactors in the Morobe District and there were no reactors during the last quarter of the year. New Britain District joined the Highlands and Northern Districts as apparently brucellosis free, as there were no reactors at the tests during 1960-61.

DISEASE CONTROL AND INVESTIGATION.

This function of the Division is centred around the Central Veterinary Laboratory, Port Moresby. Field Veterinary Officers and Stock Inspectors forward specimens for confirmation of field diagnosis. All samples for the agglutination test for *Brucella abortus* are tested in this laboratory.

Owing to the absence on study leave of the officer in charge of the laboratory, the number of specimens processed was reduced and the work output of the laboratory decreased.

Diseases diagnosed in cattle during the year included:

TUBERCULOSIS.

The position is reported above.

BRUCELLOSIS.

The position is reported above. Progress in the eradication of this disease was most promising. There has been an overall reduction of incidence from 0.95 per cent. of 7,163 sera in 1959-60 to 0.23 per cent. of 8,881 sera this year. The greatest decrease, from 2.16 per cent. to 0.23 per cent., was seen in the Morobe District, and the disease was not diagnosed on any further holdings even though the number tested increased from 38 to 51. Testing in the last quarter of the year showed no reactors. The only major cattle district where complete testing has not been carried out is Madang District. Extension of the survey to this District and to the Sepik District is expected in the coming year.

EPHEMERAL FEVER.

There have been no further cases of the disease since July, 1959, and it is evidently showing a pattern similar to that in Queensland where epizootics are followed by periods of quiescence.

PAPILLOMATOSIS.

Cases occur sporadically throughout the Territory. Wounds attractive to the screw worm occur when warts are damaged.

LISTERIOSIS.

No further cases were recorded in 1960-61.

HAEMORRHAGIC SEPTICAEMIA SYNDROME.

Further cases of an haemorrhagic disease were recorded in the Central District of Papua. No further studies were made on the bacteriology of the disease. An attempt at evaluation of the *Pasteurella bovisepctica* vaccine prepared by the Commonwealth Serum Laboratories was carried out on a Departmental herd. Following four deaths with haemorrhagic symptoms within three days among a herd of 350 cows, 100 of these cows were vaccinated whilst the remainder were left unvaccinated. Nineteen were treated with Chloromycetin intra-muscularly for four days as their temperatures were above 105° F. There were no further deaths in vaccinated, non-vaccinated or treated animals, so that no conclusion may be drawn.

INFECTIOUS KERATITIS.

No local outbreaks were recorded this year although a number of cases of keratitis occurred on animals being imported.

MYCOTIC DERMATITIS.

Sporadic cases occurred throughout the Territory.

MASTITIS.

This was a serious problem in the dairy supplying milk and cream to Port Moresby, but prompt investigation and treatment allowed a return to normal production.

HELMINTH INFESTATION.

Helminth parasites are a hazard to cattle production in the Territory because of the optimum temperature and humidity conditions for non-parasitic stages. The parasites which are most important economically are *Haemonchus placei*, *Trichostrongylus axei*, *Bunostomum phlebotomum* and *Bosicola radiatum*. The liver fluke *Fasciola hepatica* has been identified in cattle herds in the Highlands districts particularly where they were associated with sheep.

Prophylactic drenching of weaner stock, together with rotation of pastures, is recommended. The observed weaner unthrift on many properties may be partly the result of the worm burden which they carry.

CATTLE TICK (*Boophilus microplus*).

The position regarding eradication is reported above. Identifications of *Boophilus microplus* were made from specimens collected at Yule Island, Central District; Kokopo, New Britain District; Kairiru Island, Sepik District; and Kamba Village, Madang District. Eradication was instituted under Departmental control at Kokopo and Kamba. Control was recommended at the other centres until staff should be available to supervise eradication. Kairiru Island was a previously clean area, the parasite coming in on recently killed carcasses brought to the station from a tick infested area. The mission owners have begun an eradication campaign with Departmental assistance.

Infestation with *Haemaphysalis* sp. was recorded during inspections for cattle tick.

BUFFALO FLY (*Siphona exigua*).

This parasite is present on some properties in the Kokopo area of New Britain and control sprayings were carried out. Eradication is the aim but cattle and water buffalo which are not under control are acting as reservoirs of infection.

SCREW WORM FLY (*Chrysomya bezziana*).

Fly strike of wounds is observed in all Districts of the Territory except Bougainville. Records of *Chrysomya bezziana* hatched from larvae infecting wounds have been made in New Britain, Morobe and Central Districts. Although strike occurs in other districts, positive identification of the causal agent has not been made; there seems to be little doubt that *C. bezziana* is the fly involved although other *Chrysomya* spp. are recovered around carcasses, *C. megacephala* and *C. rufifacies* both being very common. In a few instances where large collections of adult flies have been made with a carcass as bait, no specimens of *C. bezziana* were collected although numerous *C. megacephala* and *C. rufifacies* were taken. This was not unexpected as *C. bezziana* is an obligate parasite while the other two are not.

Control measures consist of spraying all cattle with an insecticide of long residual effect such as dieldrin or asuntol and the treatment of all wounds with screw worm smear EQ.335. All new-born calves must be treated to prevent navel strike and routine station procedures such as branding and castrating must be carried out during periods of low fly activity. The wounds should be treated with screw worm smear and the treated animals kept under close observation until the wounds are no longer attractive to the fly.

The presence of this pest in the Territory makes it necessary for cattle to be run on a more intensive scale than in Australia. Its introduction to Australia could have serious economic consequences for Australia's pastoral industry.

PLANT POISONING.

Cycas circinalis is present throughout the lowlands of the Territory and ingestion of the leaves and seeds causes an inco-ordination in the hind quarters. Attempts at eradication of the plant are being made on most properties. The problem is severe in some parts of the Markham Valley where this cycad is extremely plentiful and regenerates readily.

Crotalaria spp. A wasting disease which occurs sporadically on a property in the Northern District of Papua has been attributed to ingestion of *Crotalaria* spp. The picture is one of progressive liver damage with the animals losing condition until they die with terminal jaundice.

Sorghum alnum was introduced accidentally and is thought to have caused two deaths at Bulolo. Treatment with sodium thiosulphate and sodium nitrate assisted other affected animals.

Iresine herbstii was blamed by Natives of the Wain Census Division of the Morobe District for a few cattle deaths. It was claimed to cause loss of condition and terminal haemoglobinuria. The plant contains a red dye which could be excreted in the urine, simulating haemoglobinuria.

INFERTILITY.

The problem of infertility in European breeds of cattle in the lowland environment causes considerable concern. The first step in its investigation has been completed since Brucellosis can no longer be regarded as a serious cause of infertility. Investigations on

the presence of Vibriosis and Trichomoniasis must also be carried out. The problem could be related directly to the non-adaptability of these animals to the tropical environment. Differential figures for the calving percentages of European breeds and Brahman crossbreds under the same conditions have been recorded in the Papuan lowlands. The European breed showed a figure of 24 per cent. (23/97) while the Brahman crossbreds showed 100 per cent. (16/16). In spite of the small number of crossbred animals involved, their high calving percentage would suggest that an infectious or deficiency disease was not the prime cause of failure to calve in the European breeds. Investigations will continue with larger numbers of animals.

DISEASES OF HORSES.

Diseases diagnosed in horses included:

A HORSE DISEASE IN THE MARKHAM VALLEY (MOROBE DISTRICT).

No new cases of the disease were seen in the year under review so that there is no further progress to report.

TETANUS.

Cases have been observed in many parts of the Territory. Vaccination of all horses with tetanus toxoid is recommended.

HELMINTH INFESTATION.

As in cattle, helminth parasites are a common cause of poor condition in horses. Those of importance are *Parascaris equorum* in foals and *Strongylus* spp. in adults.

DERMATITIS.

The two commonest causes of dermatitis are allergic reaction to insect bites (Queensland itch) and ingestion of *Leucaena glauca* (mimosine poisoning).

Regular insecticidal treatment may alleviate Queensland itch. It is often noted that some horses are not affected at all, while others in the same paddock are severely affected.

Ingestion of *Leucaena glauca* causes a loss of hair from mane and tail as well as a dermatitis. Provided that the condition is not too advanced, the removal of the animal from access to the plant will effect considerable improvement.

KERATITIS.

Cases of keratitis have been seen in several parts of the Territory, particularly in the Markham Valley. Antibiotic and cortisone preparations were used without any benefit on one property where the owner claimed that kerosine gave better results than any other treatment.

EXCESSIVE WOUND GRANULATION.

Conditions similar to swamp cancer were seen when wounds occurred, especially on limbs. Cauterization with copper sulphate and treatment with screw worm smear have shown some success. In cases where this treatment has failed, parenteral treatment with arsenic and antimony preparations has been tried with variable effect.

DISEASES OF PIGS.

Diseases diagnosed in pigs included:

ANTHRAX.

This disease is endemic among native pigs in the Eastern, Western and Southern Highlands. There is a prohibition on the movement of pigs from these districts to other parts of the Territory to prevent its spread. Outbreaks were reported regularly and vaccinations of pigs with spore vaccine were carried out.

The organism is atypical inasmuch as it is non-pathogenic to other domestic animals and man.

PNEUMONIA AMONG NATIVE-OWNED PIGS.

Virus pneumonia of pigs is almost certain to be present in the Territory but it is overshadowed by helminth and bacterial infections in Native-owned pigs kept under poor husbandry practices. Losses from pneumonia are high in such pigs, particularly in the Highlands Districts. In general, treatment with sulphadimidine will effect a recovery.

ERYSIPELAS.

This disease has been diagnosed in one commercial piggery in the Central District, Papua. The disease was seen in acute, sub-acute and chronic forms. Vaccination was undertaken and a prohibition placed on the removal of pigs from this piggery except for slaughter.

HELMINTH INFESTATION.

Helminthiasis in Native-owned pigs is a major factor in the poor growth and production of these animals. Almost any such pig shows a complete picture of the range of worm parasites present in the Territory.

Helminths are of lesser importance in pigs kept under more intensive husbandry. Results are best where the animals are restricted on concrete and this has special importance in the elimination of kidney worm (*Stephanurus dentatus*).

PIGLET ANAEMIA.

Iron deficiency anaemia is seen in piglets reared on concrete when adequate iron supplements are not provided.

DISEASES OF POULTRY.

Diseases diagnosed in poultry included:

FOWLPOX.

This disease is present throughout the Territory. Vaccination was carried out in some instances although the disease is often sporadic and self-limiting.

AVIAN ENCEPHALOMYELITIS.

Three outbreaks were diagnosed on clinical grounds, one of which, from the Morobe District, was confirmed histologically in Australia. Mortality was low (about 4 per cent.) and the morbidity slightly higher. Recovered birds gained weight equally with those which had not been affected.

AVIAN THRUSH.

This condition was diagnosed on one farm in the Morobe District where 20 per cent. of chickens were affected. *Candida albicans* was isolated from the lesions, which were confined to the mouth.

COCCIDIOSIS.

The widespread use of recommended coccidiostats has overcome the problem in flocks under good conditions of hygiene and nutrition.

HELMINTH INFESTATION.

Ascaridia galli caused many deaths in young chickens raised under restricted conditions. Other helminths commonly recorded were *Acuaria hamulosa*, *Capillaria* spp., *Heterakis gallinae*, *Oxyspiura mansonii*, *Railletina tetragona* and *Amoebataenia sphenoides*.

SLAUGHTERING AND MEAT INSPECTION.

Veterinary Officers and Stock Inspectors of the Division are responsible for the maintenance of slaughtering and meat inspection services. At present all slaughtering is carried out in small private slaughterhouses which must comply with minimum requirements. This decentralization, as well as being inconvenient for the operation of adequate inspection services, is wasteful of important by-products of the cattle industry. During the year, Ministerial approval was given for the construction of a central abattoir in Lae, and construction should commence early in the 1962-63 financial year. This announcement should encourage growers in areas serviced by Lae to expand their herds and should have a beneficial effect on the development and expansion of the whole industry.

CENTRAL DISTRICT.

Slaughtering for supply to Port Moresby was regularly carried out in two private slaughterhouses. Restrictions were placed upon slaughtering in one establishment because of unhygienic freezer facilities. As a result, fewer cattle were slaughtered this year but there was a significant increase in the slaughter of pigs. The figures were 235 cattle and 247 pigs

compared with 292 and 90 respectively in the previous year. Condemnations for generalized tuberculosis were made with two reactors diagnosed in the tuberculosis eradication campaign and other partial condemnations were made for the same reason.

NORTHERN DISTRICT.

In the latter part of the year slaughtering commenced on one property in the Northern District. After chilling, the carcasses were airfreighted to Port Moresby. Thirty-seven animals were slaughtered for this trade at the average rate of four per week and additional beasts were killed for station rations.

MOROBE DISTRICT.

Cattle were slaughtered regularly at Lae, Wau, Bulolo and Zenag and, late in the year, at Gusap also. Three hundred and sixty-three cattle were slaughtered compared with 230 head in 1959-60.

The central abattoir will provide more hygienic and efficient facilities and will permit a considerable increase in throughput.

NEW BRITAIN DISTRICT.

Killing for local consumption in the town of Rabaul was reduced to two cattle. Several plantations slaughtered regularly for their own labour lines but figures are not available.

Pigs slaughtered, mainly for the Chinese population, numbered 1,247 compared with 1,919 in the previous year.

HIGHLANDS DISTRICT.

One property regularly supplied carcasses for the town of Goroka, 60 cattle being killed during 1960-61, a decrease of ten head.

Native labour employed by the Administration at Mount Hagen and on the Western Highlands Livestock Station were supplied with fresh meat from that station, 38 animals being slaughtered for this purpose.

MADANG DISTRICT.

Occasional animals were slaughtered for supply to Madang and several plantations slaughtered for rations. Two hundred and thirteen cattle were slaughtered on twelve properties.

CLINICAL SERVICES.

Clinics were operated free of charge by Veterinary Officers in their respective districts. Table 9 lists their consultations.

TABLE 9.—VETERINARY CONSULTATIONS, 1960-61.

District.							Number of Cases.
Central	..	..	..	..	..	..	436
Morobe	..	..	..	..	..	..	264
Highlands	..	..	..	..	..	..	32
New Britain	..	..	..	..	..	..	58

The reduction in consultations was caused mainly by staff shortages.

QUARANTINE SERVICES.

The Division maintains supervision over the importation of all animals and animal products into the Territory. The Territory is freer of serious animal diseases than is Australia and the position is maintained by strict quarantine. Regular direct air services from Asian countries have increased the possibility of the introduction of the serious animal diseases of the East.

IMPORTATION OF ANIMALS.

All the animals listed below were imported from Australia.

CATTLE.

Four hundred and sixty-four head of cattle were imported under the Administration freight subsidy scheme, 301 head going to a single property in the Markham Valley. The presence of a modern vessel regularly carrying cattle from Australia to the Territory has significantly improved the rate of importation.

HORSES.

Ten horses were imported, including three stud Arab animals for private interests. Considerable interest has been shown in equestrian sports and the number of animals in pony clubs, polocrosse clubs and race clubs is high; relatively few of the horses in the Territory are used in the cattle industry or for pack work.

PIGS.

Fifty-one pigs were imported, all to piggeries around Port Moresby.

POULTRY.

There were 81,395 day-old chicks imported, while another 5,475 were transhipped to Netherlands New Guinea and 850 to the British Solomon Islands Protectorate. Three hundred and sixty-one ducklings and 280 day-old turkey poults were also imported.

SMALL ANIMALS.

Seventy-two dogs, 130 pigeons, 741 cage birds, 6 guinea pigs and 162 white mice were imported during the year.

EXPORT OF ANIMALS.

Four goats, 2 fillies and 1 part Macassar stallion were exported from Papua and New Guinea to Netherlands New Guinea.

IMPORTATION OF ANIMAL PRODUCTS.

During the latter part of the year, the importation of pigs and pig products from Australia was prohibited as a result of an outbreak of Swine Fever in New South Wales. This left only New Zealand as a source of fresh, chilled, salted, or frozen pigmeats for the Territory.

VETERINARY RESEARCH.

VETERINARY LABORATORY.

The major part of the output of the laboratory during 1960-61 was concerned with diagnostic work for the Veterinary Officers. The Officer in charge of the laboratory was absent for all but one month of the year under review so that no research was undertaken.

ANIMAL HUSBANDRY.

PIGS.

Since the only domesticated animal in traditional Native agriculture is the pig, the Department has embarked upon a plan to improve the type of pig owned by the indigene, and to improve his husbandry methods so that production will become more efficient. Although the indigenes are already familiar with the pig, this in itself poses certain problems, and considerable education will be required to change the traditional attitudes towards it. At present the pig has great prestige value and is only incidentally regarded as an item of food. This attitude must be modified so that it will occupy a useful niche in improving nutrition and providing income. In some ways it is more difficult to modify an established attitude than to teach *de novo*. There is an inevitable tendency to cling to old practices, especially as in this instance they are not only hallowed by time and tradition but also have certain social and magico-religious associations in many areas.



Plate 1—Territory cattle are tested in the tuberculosis eradication programme.

[Photo : D.I.E.S.]



Plate 2—Imported pigs (left) have a far better performance than village pigs (right)

[Photo : D.I.E.S.]

The improvement of pig production under village conditions is being approached in two ways, namely by the distribution of an improved type of pig and by improvement of pig husbandry.

To achieve the first aim, the Department has established piggeries at Goroka and Baiyer River in the Highlands, Erap in the Morobe District, and Kurakakaul, near Rabaul, New Britain District. These piggeries are stocked with stud Berkshires imported from Australia and raised under intensive husbandry methods. During 1960-61, they sold 349 pigs, over 75 per cent. of which went to Papuans and New Guineans.

The difference in growth rates and conformation of imported and village pigs is clearly shown in Plate 2. The pig on the left is a ten-week-old Berkshire; in the right foreground are two native pigs of about the same age; one of the sows behind them, although only the size of the Berkshire, is their mother.

The trial project involving the housing of Berkshire stud boars in various centres through the Highlands was not as successful as was expected; the scheme has been modified slightly to allow for the transfer of the boar to a specially constructed house in each village. The use of a stud boar in this way is the quickest way to upgrade local pigs.

The improvement of Native pig husbandry must depend upon and follow the social and economic advancement of the people. At present the pig is a grazing animal in the village economy and his upkeep places no drain on the owner; any improvement in husbandry must increase the cost of rearing pigs. Progress towards improved husbandry is seen in areas where cash crops have been planted on a large scale. In these areas the free grazing habits of pigs cause damage in crop gardens and there are moves to confine them.

However, a complete changeover to the housing of all pigs would at present prove economically disastrous. Not only is the capital cost of the housing high, but the recurring food needs of the pig would mean the maintenance of much larger gardens. The change to more intensive husbandry must be gradual as the villager learns the benefits of housing and feeding to produce pigmeat economically.

CATTLE.

Since pigs are not an efficient grazing animal, the Department is encouraging the introduction of cattle to replace them in natural grazing areas.

The largest concentration of cattle owned by indigenous people is in the Morobe District of New Guinea, where 320 cattle and 10 horses are under indigenous control. Of these, all the horses and 225 cattle are in the Wain, Naba and Erap Census Divisions. The remainder of the cattle are in the Finschhafen area (75) and the Kaiapit area (20). The Wain, Naba and Erap Census Division areas are above 3,000 feet where European-type cattle thrive. The other areas are on the coast and really require heat tolerant strains of cattle. Husbandry in these projects is based upon the use of a paddock in which the animals are restrained during the night and open grazing with herdsman during the day.

The pilot projects commenced by the Department in the Eastern Highlands during 1959-60 have proved a success and the extension of similar projects to other areas was undertaken this year. The large numbers of applications received from New Guineans who wished to participate in the scheme is indicative of the interest in its extension. There are 59 cattle under Native ownership in the Eastern Highlands and the rapid expansion of the project seems limited only by the supply of animals from Departmental herds and the training of New Guineans in animal husbandry on Departmental stations.

Some of the problems which have become apparent in the pilot projects are:

- (i) The training of Native cowhands has not always been adequate.
- (ii) There was frequently failure to move cattle out to grazing early enough in the mornings and to return them as late as possible at night. This resulted in serious over-grazing of the night paddock.
- (iii) Young heifers were not separated from the herd to prevent mating too early.
- (iv) Calves were not properly weaned and bulls were not rotated around projects.
- (v) There was difficulty in the establishment of improved pastures where pigs were allowed free range.

Most of these problems can be overcome by correction of the first fault through better training. Intensive training of Native farmers for twelve months in animal husbandry methods will be undertaken; the period is necessarily long because cattle husbandry is a completely new concept to them.

LIVESTOCK STATIONS.

Eight livestock stations are operated by the Division throughout Papua and New Guinea. Two, the Animal Quarantine Station and Veterinary Laboratory, Kila Kila, Port Moresby, and the Animal Industry Centre, Three Mile, Lae, function as quarantine areas and bases from which Veterinary Officers and Stock Inspectors operate. The Papuan Lowlands Livestock Station, Moitaka; the Papuan Highlands Livestock Station, Bisianumu; the New Guinea Lowlands Livestock Station, Erap; and the Western Highlands Livestock Station, Baiyer River, maintain herds of cattle for experiment and for distribution. The Animal Industry Centre, Goroka, maintains a dairy herd and a large stud piggery project. The Animal Industry Centre, Kurakakaul, Rabaul, functions as a quarantine area and Veterinary Centre as well as maintaining a dairy herd and piggery project.

The Upper Ramu Livestock Station, Arona, was disposed of by tender during the year, the final handover taking place in April, 1961.

At 30th June, 1961, these stations carried 2,984 cattle, 314 horses, and 145 pigs. Table 10 shows the livestock statistics for all Animal Industry Stations for the year under review.

Four major projects are under way on Divisional stations, as follows:

ZEBU CROSS-BREEDING PROJECT.

This is being carried out in two parts:

- (i) Brahman cross-breeding on the Papuan Lowlands Livestock Station, Moitaka, where Angus is the European breed used. Poll-Shorthorns were used as basic stock in a grading-up programme to Brahman bulls to increase the number of grade Brahmans available for the Territory.
- (ii) Africander cross-breeding on the New Guinea Lowlands Livestock Station, Erap, where Poll-Shorthorns are the European breed. Selection within the Shorthorn herd towards a more adapted type is also carried out. Africander-Shorthorn bulls have also been used in the breeding programme on the Western Highlands Livestock Station, Baiyer River.

These two projects are aimed at developing a type of animal adapted to the tropical lowland environment of the Territory. Progress will be covered more fully in the Station reports which follow.

DAIRY CATTLE IMPROVEMENT PROJECT.

Dairy cattle are maintained on three of the stations. The Papuan Lowlands Livestock Station, Moitaka, and the Animal Industry Centre, Kurakakaul, run Jersey cattle, while at the Animal Industry Centre, Goroka, A.I.S. cattle are used; Jersey cattle are better adapted to the hot lowland environment than A.I.S. Selection based on production per lactation of 305 days is carried out on these herds.

PIG BREEDING PROJECT.

Stud Berkshire pigs are maintained at the Animal Industry Centre, Goroka; New Guinea Lowlands Livestock Station, Erap; Animal Industry Centre, Kurakakaul; and the Western Highlands Livestock Station, Baiyer River. Breeding is based on selection for litter size and body weight gain under the prevailing conditions. Most of the animals bred on these stations are available for distribution and many are sold to Native peoples.

BEEF CATTLE BREEDING PROJECT.

Breeding of European breeds of cattle is carried out at the Papuan Highlands Livestock Station, Bisianumu (Angus) and the Western Highlands Livestock Station, Baiyer River (Poll-Shorthorns). The surplus cattle are available for distribution, primarily to Native cattle projects. Selection within these herds is directed towards conformation, weight gain and coat type.



Plate 3—The superior growth of calves with a high percentage of Brahman blood is evident in this pen of calves ranging from $\frac{1}{4}$ to $\frac{3}{4}$ Brahman.

[Photo : D.I.E.S.]



Plate 4—Brahman heifers at Bisianumu. The black animal is Brahman-Angus.

[Photo : Australian News and Information Bureau.]

TABLE 10.—LIVESTOCK STATISTICS FOR ANIMAL INDUSTRY STATIONS.

Station.	Cattle.						Horses.						Pigs.					
	Total 1st July, 1960.	Natural Increase and Transfers In.	Deaths.	Slaught- ered for Con- sumption.	Sales and Transfers Out.	Total 30th June, 1961.	Total 1st July, 1960.	Natural Increase and Transfers In.	Deaths.	Slaught- ered for Con- sumption.	Sales and Transfers Out.	Total 30th June, 1961.	Total 1st July, 1960.	Natural Increase and Transfers In.	Deaths.	Slaught- ered for Con- sumption.	Sales and Transfers Out.	Total 30th June, 1961.
Moitaka	778	176	34	6	67	847	63	20	10	..	6	67	..	..	..	..	..	..
Bisianumu	258	64	10	..	48	264	9	1	..	..	5	5	..	..	..	..	..	..
Erap	504	109	33*	14	73	493	59	5	5	..	4	55	28	133	28	7	98	28
Arona	54	4	13	..	..	45†	65	17	22	..	4	56†	5	39	3	..	22	19†
Goroka	34	14	2	4	11	31	1	..	..	..	..	1	149	165	16	26	200	72
Baiyer River	1,010	255	36	49	26	1,154	112	11	6	1	..	116	7	18	1	1	16	7
Kurakakaul	160	35	8	..	37	150	14	2	1	1	..	14	37	56	17	..	57	19
	2,798	657	136	73	262	2,984	323	56	44	2	19	314	226	411	65	34	393	145

* Includes 18 slaughtered for disease eradication.

† Figures at April, 1961, handover to purchaser.

The activities of the eight Stations during 1960-61 are summarised below.

PAPUAN LOWLANDS LIVESTOCK STATION, MOITAKA.

During 1960-61 a new station boundary was defined and partly fenced. The area now enclosed for station use is 13,175 acres, of which 9,000 acres is eucalypt savannah country carrying mainly kangaroo grass, 3,175 acres is rain forest country on the alluvial flats of the Laloki River, and 1,000 acres is swamp. The alluvial country is well suited to the establishment of permanent improved pasture after the rain forest is cleared.

The climate is typified by constant high temperatures, relatively high humidities and a wet season from December through to March or April.

LIVESTOCK.

CATTLE (DAIRY).

A herd of 91 Jersey cattle was maintained on the station to experiment in milk production in the local environment and to select animals which produced well under the local conditions.

The cows were milked by machines twice daily and production was recorded once every fourteen days at the morning and evening milking. Lactations were terminated as close to 305 days as possible, but as shown by the figures below, the majority of the cows dried off before this stage was reached. In Table 11, the figures are arranged in decreasing length of lactation period and include all lactations concluding in the 1960-61 financial year.

TABLE 11.—LACTATION OF JERSEY COWS AT MOITAKA.

Cow No.							Lactation Length (Days).	Milk Production (lb.).
3,040	..	..	..	..	..	..	358	6,284
3,058	..	..	..	..	..	..	357	6,707
3,032	..	..	..	..	..	..	313	6,016
3,037	..	..	..	..	..	..	306	3,372
3,048	..	..	..	..	..	..	306	2,519
3,040	..	..	..	..	..	..	302	4,303
3,024	..	..	..	..	..	..	300	5,685
3,004	..	..	..	..	..	..	299	3,979
3,033	..	..	..	..	..	..	297	4,633
3,055	..	..	..	..	..	..	275	4,105
3,017	..	..	..	..	..	..	269	3,793
3,020	..	..	..	..	..	..	267	3,157
3,023	..	..	..	..	..	..	263	2,850
3,036	..	..	..	..	..	..	246	3,912
3,043	..	..	..	..	..	..	245	3,677
3,044	..	..	..	..	..	..	244	2,410
3,045	..	..	..	..	..	..	241	2,534
3,034	..	..	..	..	..	..	226	2,497
3,059	..	..	..	..	..	..	226	2,770
3,046	..	..	..	..	..	..	210	3,298
3,007	..	..	..	..	..	..	200	1,379
3,035	..	..	..	..	..	..	149	2,078
3,049	..	..	..	..	..	..	141	1,700
3,051	..	..	..	..	..	..	141	1,837
3,022	..	..	..	..	..	..	139	1,306
3,053	..	..	..	..	..	..	139	1,768
3,062	..	..	..	..	..	..	139	1,264
3,019	..	..	..	..	..	..	82	674
3,010	..	..	..	..	..	..	76	690
3,052	..	..	..	..	..	..	75	707
3,005	..	..	..	..	..	..	70	700
3,050	..	..	..	..	..	..	68	210
3,039	..	..	..	..	..	..	44	300

The mean production for all animals under test was 2,851.9 lb. of milk. The culling of only a small number of the low producers would raise this mean considerably while part of the reason for the low figures could be the advancing age of many of the animals. All test animals were original imported cows nine years or more of age. There are on hand 38 young heifers between 1 and 22 months of age which will be introduced into the herd.

The breeding plan for the dairy project consists of retaining bull calves from the best producers and using these bulls over the whole herd. Dam-daughter comparisons will also be made to attempt to evaluate the bulls at present in use but these comparisons will be handicapped by the records of the mothers having been made at such a late stage in their productive life.

No further progress can be reported on the proposed dairy cross-breeding programme using Sahiwal and Sindhi animals as the latter have not yet been imported into the Territory.

CATTLE (BEEF.)

The Brahman cross-breeding programme is progressing satisfactorily. The calf drop for the year consisted in the main of crossbred animals of three quarters, one half and one quarter Brahman blood. A pen of heifers with one quarter to three quarters Brahman blood is shown in Plate 3. Angus bulls were used only towards the end of the mating to assist in the coverage of the breeding cows. The calving percentage was disappointing, being only 30.6 per cent., but the following factors were probably contributory:

- (i) The age of the breeding cows. Over 50 per cent. of the breeders were imported cows and at the time of mating were nine years of age or over. However, figures extracted from within the Angus group do not support the suggestion that age was a factor contributing to low fertility. Imported cows, nine years of age or over, gave a calving of 26 per cent. (16/62) while the locally bred cows, three to six years of age, gave a calving of 20 per cent. (7/35), the overall figure being 24 per cent. as mentioned above.
- (ii) Low percentage of bulls used. The shortage of Brahman bulls allowed a mating percentage of only 2 per cent. The Brahman-Angus F1 bulls were used at 4 per cent and these bulls were only two years of age.
- (iii) The problem of infertility in European cows in the tropical environment. Differential calving percentages of Angus cows and Brahman crossbred cows mated to the same bulls have been extracted from the records. These figures showed a 24 per cent. (23/97) calving in Angus cows and a 100 per cent. (16/16) calving in Brahman crossbred cows. The number of crossbred cows was small compared with the number of Angus cows but the difference is highly significant.

Fully comparative figures for calving percentage of Angus and Brahman crossbred animals in the same age group are difficult to obtain because of the poor growth rate of Angus cattle in the local environment and the need to hold Angus heifers for an extra year so that they will have grown sufficiently for mating. This will be shown in the following section on growth rate observations.

A weight gain trial using Angus heifers and Brahman Angus F1 heifers was begun during the year. The results of the trial are shown graphically in Figure 6 and in tabular form in Table 12. The animals were weaned on to natural Kangaroo grass country and have been maintained on this type of country throughout the trial.

TABLE 12.—COMPARATIVE WEIGHTS OF ANGUS AND BRAHMAN-ANGUS CALVES.

Month.	Angus (lb.)	Brahman-Angus (lb.).	Rainfall (Points.)
Mid-August	331.2	407.2	..
September	322.4	405.6	98
October	317.6	414.4	19
November	318.4	427.2	141
December	329.6	459.2	330
January	364.4	528.4	621
February	433.6	576.4	1,006
March	452.8	625.6	467
April	468.8	644.6	228
May	466.4	670.4	685
June	472.0	700.0	158

The mean weight gain by the Angus group for the period of the trial was 140.8 lb. compared with the mean weight gain by the Brahman-Angus group of 292.8 lb., a 108.7 per cent. increase in the rate of gain by the latter over the former.

In addition to the obvious weight gain advantage, the Brahman-Angus heifers were ready to mate at the end of the period, while the Angus were not sufficiently well grown to mate until a year older. The weight gain observations will be continued on this group for another twelve months and similar observations will be carried out on three-quarters, one-half and one-quarter Brahman heifers weaned from this year's calving.

The second annual sale of Brahman cross yearling bulls was held on the station in June, 1961. The demand for this type of animal seems to be increasing and bidding at the sale was spirited. The results were as follows:

							£
5 head	$\frac{3}{4}$	Brahman	$\frac{1}{4}$	Shorthorn	bulls		1,360
2	..	$\frac{1}{2}$	..	$\frac{1}{2}$		..	175
8	..	$\frac{1}{2}$	..	$\frac{1}{2}$	Angus	bulls	900
Total							2,435

Five Jersey bulls, together with 3 Brahman cross bullocks and 10 Angus weaner steers, were also included in the sale. The offering of 33 head returned £2,887 10s.

The interest of the public in the Brahman cross bulls, particularly those of three-quarters blood, is most satisfying and indicates the need for this type of animal in developing cattle suited to the hot lowland environment of the Territory. With the breeding programme under way, more of these animals will be available for disposal in coming years and the proportion of Brahman blood in them will increase from the grading up programme.

These releases of Brahman cross cattle are the first stage of the Division's programme in fostering the development of heat tolerant types of cattle which will produce well in the difficult coastal environment of Papua and New Guinea.

HORSES.

Nine foals were born to station mares by the imported stallion "Woodmaster". These foals showed considerable improvement over the general type of horse on the station. The small number of foals was a result of a serious attack of laminitis suffered by "Woodmaster" which kept him out of service for almost six months.

Breeding was also handicapped by the lack of suitable brood mares. Many of the better type mares were old, having been imported as broken horses in 1950. Young mares were, in the main, progeny of a pony stallion and unsuitable for breeding type stock horses. Several wild horses were captured during the year, some of which may provide good stock horses when mated to "Woodmaster".

Seven privately owned mares were accepted for service during 1960-61.

GOATS.

The Division does not recommend the widespread distribution of goats throughout the Territory because of their extremely destructive grazing and browsing habits, which could have a detrimental effect upon the subsistence agriculture of the villages. As a result, goat breeding is being discontinued and the animals are being used for rations.

CAPITAL IMPROVEMENTS.

Two new houses for European officers were commenced during the year.

The main stockyards at Waigani have been maintained in excellent condition. A second set of yards of similar design but smaller capacity, containing a Cooper spray race, were constructed at Durand Strip to handle cattle being grazed on the improved pasture in this area. No weighing facilities are available in these yards. The yards at the dairy are in a poor state of repair and will be replaced as part of the dairy rebuilding project. Two wells were sunk to supply water to two paddocks without permanent natural water, one being equipped with windmill, tanks and troughing. A water reticulation scheme for the improved pasture paddocks on Durand strip was commenced in June. The scheme will allow better utilization of the pasture by providing water points in each paddock and will also provide water for the yards and spray race mentioned above.

Two miles of boundary fencing and approximately seven miles of sub-divisional fencing remain to complete the fencing programme.

FODDER CONSERVATION AND PASTURE IMPROVEMENT.

Unusually well distributed rainfall providing almost continuous pasture growth, together with the high carrying capacity of improved pasture established during the last two years, enabled the maintenance of the cattle without supplementary feeding of conserved fodder. This is the first time in the history of the station that this has been possible. As a result, 1,000 tons of silage is still stored in trench silos as a drought reserve.

The area of elephant grass (*Pennisetum purpureum*) pasture at Durand strip was increased to 320 acres. This pasture carried 317 cows and their calves during the dry season. Extension of this pasture was limited because of the unusual wet season which did not provide sufficient rain to enable more extensive planting. Centro (*Centrosema pubescens*) and phasey bean (*Phaseolus lathyroides*) were planted in conjunction with the elephant grass.

Approximately 50 acres of Para grass (*Brachiaria mutica*) was planted around the swamps in the Waigani and Koha areas. This grass produces well on the swamp margins and is a useful supplement to the elephant grass pastures.

Molasses grass (*Melinis minutiflora*) was planted in the scrub burns. Its establishment was patchy and it was badly affected by the onset of the dry season.

Five hundredweight of centro seed and two hundredweight of phasey bean seed were harvested for replanting and distribution to other stations. These two legumes, together with Townsville lucerne (*Stylosanthes sunaica*) are becoming widely distributed on the station.

Guinea grass (*Panicum maximum*) is grown under irrigation in the dairy section. These pastures, together with an area of 16 acres of elephant grass, also irrigated, ensure a constant supply of green feed for the milking cows. The Guinea grass, which is oversown with centro and puero, is strip grazed with the help of an electric fence and the milk production of the dairy has improved considerably from this grazing.

PAPUAN HIGHLANDS LIVESTOCK STATION, BISIANUMU.

Further development was concentrated on the rain forest section where extension of the Guinea grass pastures was undertaken. This section of the station has much greater potential for pasture improvement than the remaining savannah forest.

LIVESTOCK.

The livestock on the station at 30th June, 1961, are shown in Table 10.

CATTLE (BRAHMAN).

The Division's stud Brahman animals are held on this station and are the basis of the cross-breeding programme being carried out on the Papuan Lowlands Livestock Station, Moitaka, which is described above. Plate 4 shows a group of Brahman breeders and calves at Bisianumu. One cross calf is included in the group.

During 1960-61 four bull calves and two heifer calves were born to the breeding herd. Breeding difficulties which appeared to be associated with the suppression of oestrus by lactation have been experienced and have caused an extended interval between calvings of over fifteen months, the length of the calving interval depending upon the age of weaning of the calves. During the latter part of the year, a heifer calf was removed from her mother five days after birth and transferred to the dairy on Moitaka to be bucket fed. By this means it was hoped to reduce the calving interval to twelve months and so increase the herd more rapidly.

The four bulls calved during 1959-60 were transferred to Moitaka for use in the crossbreeding programme and will make a very important contribution to this programme, which has been impeded in the past by the shortage of Brahman bulls.

An interesting observation was made on one of the cows during the year. She aborted a five-month heifer calf on the 11th October, 1960 and on the 24th February, 1961, she calved a full-term bull. This most unusual phenomenon could be explained by the presence of twins to a mating in May, 1960.

ANGUS.

This breed is maintained for the breeding of replacements for the Papuan Lowlands Livestock Station, Moitaka, to which 39 cows and heifers were transferred during the year. The breeding herd of 98 cows produced 73 calves, a calving percentage of 74.5 per cent. A problem of unthriftiness in calves was traced to an infestation with hookworm (*Bunostomum phlebotomum*) and a programme of drenching and rotational grazing was instituted to combat it.

RED POLL.

This dual purpose breed is maintained for distribution as needed. The small herd was grazed under untapped rubber.

HORSES.

A colt foal was born to one of the station mares by the thoroughbred stallion imported during 1959-60. There were only three saddle hacks on the station other than this mare and foal. Because of the broken nature of the country, the cattle are best worked by Natives on foot.

CAPITAL IMPROVEMENTS.

A new single labour quarters was constructed and alterations were made to some of the other buildings to facilitate the work.

Repairs and maintenance were carried out on the stockyards, and repairs and some alterations to sub-divisional fencing were made. The station is completely boundary fenced.

PASTURE IMPROVEMENT.

The planting of Guinea grass continued and about 75 acres of the rainforest and marginal country now has this grass planted thinly through it. It is hoped that good management will allow it to spread. A small plot of Guinea grass was planted in savannah country to test its value under these conditions.

Carpet grass (*Axonopus compressus*) continued to spread in the pastures of the rainforest country. On other properties in the Sogeri area, this grass stands up to heavy stocking.

ANIMAL QUARANTINE STATION, KILA KILA.

The main function of this station is the maintenance of experimental animals for use in the Central Veterinary Laboratories situated there. There are also available full facilities for the strict quarantine of cattle or horses entering Papua.

LIVESTOCK.

The experimental animals consisted of 7 cattle, 1 horse, 3 sheep, 2 deer, and several goats. Colonies of Guinea pigs and laboratory mice were also maintained.

CAPITAL IMPROVEMENTS.

A store for the veterinary laboratory was completed and a start made in the conversion of the unfinished Biochemistry laboratory into a laboratory for use by the Chemistry Section of the Plant Industry Division. The incinerator commenced during 1959-60 was completed.

PASTURE IMPROVEMENT.

Increased areas of Guinea grass were planted in an area where it can be irrigated during the severe dry season. Plots of elephant grass were also planted.

ANIMAL INDUSTRY CENTRE, THREE MILE, LAE.

This is the Quarantine Station for the port of Lae and is kept in readiness for receiving imported cattle. It is the first line of defence for the detection of livestock diseases and for post-entry treatment of animals as part of the measures being taken to prevent the re-entry of cattle tick into the Territory. It also serves as a base for the District Veterinary Officer and Stock Inspector who have a small field laboratory and store and office there.

The few Administration-owned livestock on the Station comprised a small number of Jersey cattle in transit to Extension Centres and horses for the handling of imported livestock.

During the year, 454 cattle and 4 horses were imported and handled through the Station, some of the cattle being staged for periods up to six weeks.

NEW GUINEA LOWLANDS LIVESTOCK STATION, ERAP.

This Station is the centre of the Africander cross-breeding programme. It is situated in the Markham Valley, the area of New Guinea which shows greatest potential for the rapid development of a cattle industry, with a hot lowland environment and an annual rainfall of about 60 inches, falling in two distinct wet seasons.

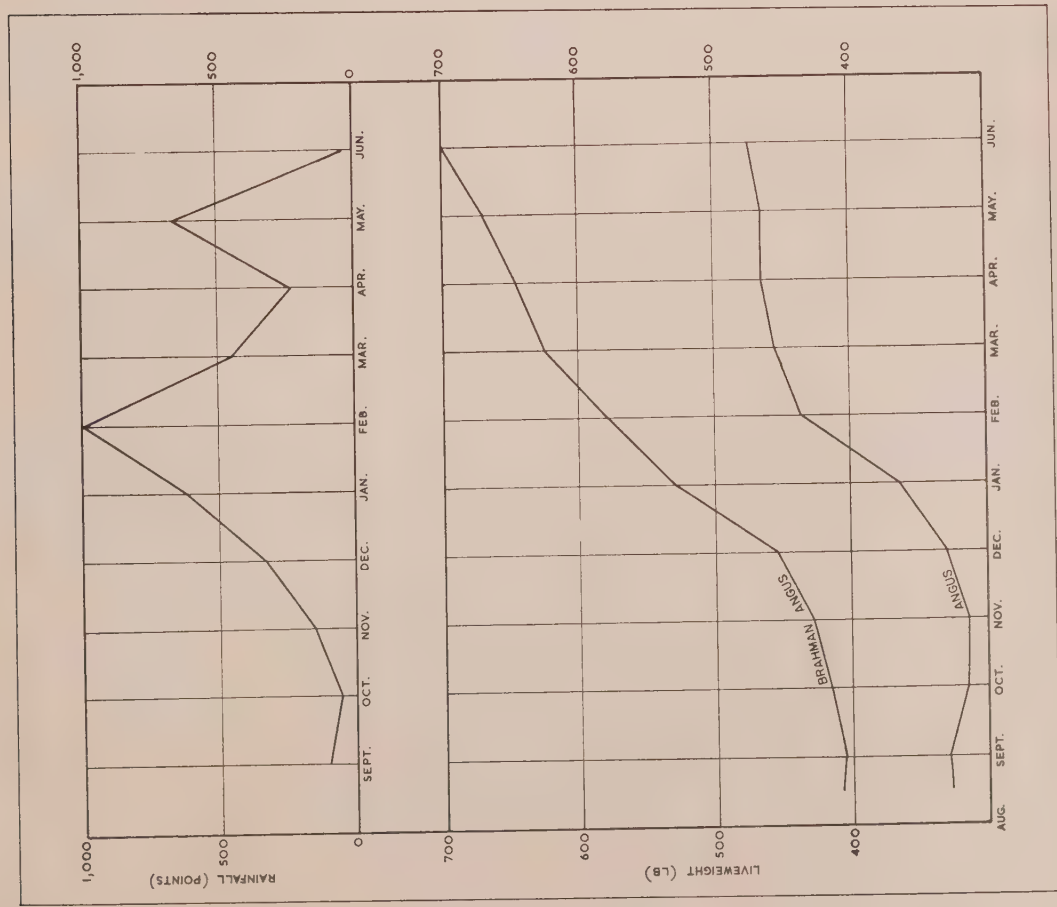


Figure 6—Comparative weight gains of Angus and Brahman-Angus calves at Maitaka, in relation to rainfall.

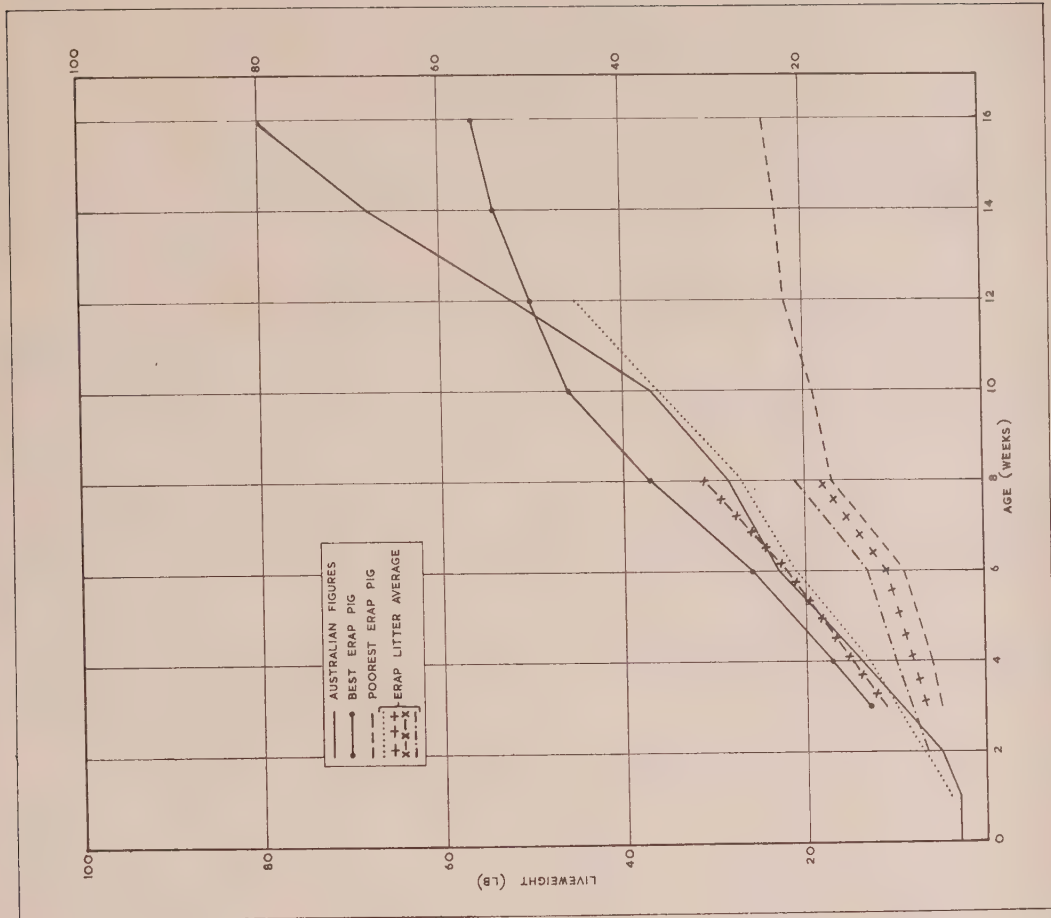


Figure 7—Comparative weight gains of pig litters at Erap, in relation to the Australian average.

LIVESTOCK.

The livestock present on the Station at 30th June, 1961, are shown in Table 10.

CATTLE.

A herd of Beef Shorthorn cattle is run. Two breeding programmes are in operation, one to cross-breed Africander and Shorthorn to produce an animal adapted to the local environment, and a second to select Shorthorns from within the present stock on the basis of coat type and production in an attempt to develop a type of Shorthorn which will thrive under the local conditions.

Extremely poor results in the breeding programme were experienced this year, the overall calving percentage to the mating in March, 1960, being 19.6 per cent. The percentage was reduced significantly by the failure of one Africander bull which reacted positively to the agglutination test for brucellosis and his libido was very low. This bull had a calving percentage of 10 per cent. and the cull group of 4 Shorthorn bulls had a calving percentage of 14 per cent.

A subsequent mating was carried out in December, 1960, and January, 1961, using 1 Africander bull, 4 Africander-Shorthorn F1 bulls and 4 Shorthorn bulls. The pregnancy diagnosis on this mating showed 25 per cent. of the cows to be pregnant. The Africander bull gave a 40 per cent. pregnancy diagnosis which, although better than the earlier figure, was still not good.

These two matings would seem to indicate a problem of infertility in European breeds of cows under lowland conditions, similar to that found on Moitaka. This problem will be further investigated in the coming year.

The matings for 1961 are summarized in Table 13:

TABLE 13.—MATINGS OF SHORTHORN COWS AT ERAP, 1961.

Family.					Bulls.	Cows.
1	..	..	..	..	1 Africander	30
2	..	..	..	..	4 F1 Africander-Shorthorn ..	104
3	..	..	..	..	4 Shorthorn	72
4	..	..	..	..	4 Shorthorn	76

Special attention was paid to the animals during mating both to observe frequency of oestrus and to keep the bulls moving among the cows and ensure that they were active in serving them.

Regular inspections were made during 1960–61 for reinfestation with cattle tick, but none was sighted. It would appear that the eradication programme has been a success.

Eighteen cattle were slaughtered in disease eradication programmes, 6 for tuberculosis and 12 for brucellosis. With both diseases the eradication programmes have shown some success, there being no reactors in the last quarter to either disease.

A successful auction sale of cattle was held in May when 35 stores and 32 cull heifers were offered, together with pigs and surplus equipment.

PIGS.

The stud Berkshire pigs introduced in 1959–60 produced well during the year and three grade sows were also retained in the breeding herd. Eleven stud sows produced fourteen litters during the year with an average of 8.6 piglets per litter. The three grade sows produced five litters with an average of six piglets per litter. Table 14 gives an analysis of the causes of deaths in each group:

TABLE 14.—CAUSES OF DEATH OF PIGLETS AT ERAP.

				Piglets Born.	Born weak, Died soon after Birth.	Overlying.	Other Causes.	Number Reared.
Stud	..	..	..	121	10 (35 per cent.)*	14 (50 per cent.)	4 (15 per cent.)	93
Grade	..	..	..	31	8 (68 per cent.)	4 (32 per cent.)	0	19

* The figures in brackets represent the percentage of total deaths.

During the year, circular farrowing pens were installed in an attempt to reduce the serious losses caused by overlying.

Weight gains of litters were recorded and compared reasonably with Australian averages; some litters grew at the Australian average rate but most were below it. The high environmental temperatures experienced at Erap had an effect on growth rate, which improved after grass thatch was placed over the top of the corrugated iron roofs of the pens. Weight gains are shown graphically in Figure 7.

A selection programme based upon litter size and growth rate was practised to replace breeding sows and to increase the number of breeders. Culling was carried out when sows produced two consecutive litters of less than six.

Rations were compounded from meatmeal, reject wheatmeal, rice bran, sorghum, and reject rice. Reject peanuts were also available for part of the year. Creep feeds were prepared from meatmeal, skim milk powder, sugar and sorghum. Iron supplements were given to the piglets in the form of reduced iron orally.

Ninety-eight pigs were sold or transferred off the Station during the year, the majority being purchased by New Guineans.

HORSES.

Horses are kept for working the cattle on the station. Three foals were born to mares served by the stallion "High Adventure" during his time on the station en route to the Western Highlands Livestock Station, Baiyer River. A part Macassar stallion was on the station for most of the year. He was sold to the Netherlands New Guinea Administration.

The horses were severely troubled by a skin condition which was similar to Queensland itch. Regular spraying with insecticides did not seem to alleviate the condition although applications of screw worm smear seemed to help.

DONKEYS.

The donkeys were used by New Guineans of the Upper Erap Valley to carry produce down to the Markham Road. The donkeys in the train were returned to the Station after each trip to be rested, and were replaced with fresh animals.

CAPITAL IMPROVEMENTS.

A house was completed and is now occupied by the Officer-in-Charge.

The "maternity section" of the piggery—six circular farrowing pens—was completed. These should reduce the considerable losses in piglets from overlying.

The new stockyards were still incomplete at the end of the year. The yards include a spray race, calf handling equipment and a weighbridge.

Six bores were drilled by a contractor and sited so as to provide water points in each paddock. They will be equipped progressively over the next three years. Water was found between 55 ft. and 65 ft. in the middle of the Station and between 14ft. and 35 ft. at the level of the houses.

PASTURE IMPROVEMENT AND CROPS.

One hundred acres of improved pasture was sown. The species planted were:

- (i) Elephant grass—22 acres was planted in the bull paddock on the better type soils.
- (ii) Guinea grass—57 acres was planted, 37 acres with tussocks and 20 acres with seed. All the area planted with tussocks established well, except for a small portion on gravel soils. This soil was nitrogen deficient and was heavily sown with Centro in an attempt to improve the grass growth. Seed strike was excellent in one area but poor in another. The reason for the difference was not apparent.
- (iii) Buffel grass—20 acres seeded showed a very poor strike. The seed was poor and weather conditions were unfavourable.
- (iv) Centro—This was seeded in conjunction with the grass plantings and germination was good. Large quantities of seed were purchased from local villagers for future sowing.

Maize and sorghum were grown for supply of grain to the piggery.

ANIMAL INDUSTRY CENTRE, GOROKA.

The progressive abandonment of the 284 acre section of the Station which has been resumed into the town plan was carried out during the year and development was confined to the 85 acre Stud Piggery site four miles from the town.

LIVESTOCK.

The livestock on the Station at 30th June, 1961, are shown in Table 10.

CATTLE.

The reduction in area of the Station has seriously reduced the cattle breeding programme and the A.I.S. dairy herd was reduced to fifteen breeding cows. Bulls from the herd were made available for use in Native cattle projects but the number of heifers for sale to these projects was very small.

When development of the stud piggery is complete, an improved husbandry system will be introduced and the number of cattle will be increased to the maximum carrying capacity. Records of milk production will be maintained and selection will be based on these records.

PIGS.

The stud Berkshire pigs which form the basis of the Division's plan to improve the type of pig owned by Natives, are kept under an intensive husbandry system at all times.

Rations were compounded as much as possible from locally-grown foodstuffs. Meatmeal and mineral supplements were imported but the grains and sweet potatoes were grown on the Station or purchased locally. The resumption of the main Station limited grain production at Goroka but the difficulties have been largely overcome by growing grain on the Western Highlands Livestock Station, Baiyer River.

During 1960-61, 165 piglets were born in 33 litters, an average of five piglets per litter. The litter sizes at Goroka were disappointing when compared with those at Erap and Kurakakaul. Some of this could have been caused by the age of the sows at their first mating; they were over three years at mating because of quarantine in Port Moresby prior to delivery to Goroka.

A culling and selection programme was commenced in an attempt to improve litter size. Sows were culled when they produced two consecutive litters below the herd average and also when they failed to conceive following three consecutive oestral cycles after weaning a litter. Pigs were selected for retention in the herd on weight gain within large litters. One sow was retained from each litter of seven and two sows from each litter of eight or above, one boar from each litter of nine or ten and two boars from each litter of eleven or above.

One hundred and ninety-five pigs were sold from the station during the year and five were transferred, two going to Baiyer River and three boars to pens established at Kundiawa, Kerowagi and Henganofi.

CAPITAL IMPROVEMENTS.

Three double Native married quarters were constructed of river stone and cement with galvanized iron roofs, flat iron ceilings, lining, louvre windows and furniture.

The office from the main station was removed to the labour compound at the piggery and serves as extra labour accommodation.

A weighing room, sick bay, and operating room were constructed within the piggery.

Creep feeding pens were cemented at the rear of piggery Blocks Nos. 1 and 2.

Two steel framed store sheds from the main Station were dismantled and re-erected at the piggery. They are being used as store and feed sheds, implements shed, and saddlery and carpenter's shops.

The boiler room and foundations for the boiler were completed, the latter awaiting installation by a boiler mechanic.

WATER SUPPLY.

An earth dam was excavated. It is fed by a water race and as it is on high ground, a siphon system is used to supply water under pressure.

PASTURE IMPROVEMENT AND CROPS.

Pasture improvement using elephant grass and para grass was carried out on the piggery site and 16 acres was permanently established. The para grass can be irrigated from the water race and dam if necessary.

Forty acres of sweet potato and 30 acres of maize for grain were planted, mainly on the main Station, together with 10 acres of maize for grazing.

WESTERN HIGHLANDS LIVESTOCK STATION, BAIYER RIVER.

Baiyer River Station will produce the major percentage of cattle for the development of a Native cattle industry in the Highlands districts.

LIVESTOCK.

The livestock on the Station at 30th June, 1961, are shown in Table 10.

CATTLE.

Poll-Shorthorn cattle are bred, and during the year two Africander-Shorthorn F1 bulls were introduced in an attempt to eliminate some of the long coat characteristics of the Shorthorn. The Shorthorns themselves were selected on coat score, conformation and growth rate.

Of the 440 breeders joined in the 1959-60 mating, 90 were culled for unthriftiness and inability to rear calves. Three hundred and fifty breeders were mated with 4 per cent. bulls in September, 1959, and of 270 calves born, 253 were marked. This is a calving percentage of 77 per cent. and a marking percentage of 72.3 per cent. Calving commenced again in June from the mating in September, 1960, and 53 calves were born to June 30th. The Africander x Shorthorn bulls were included in this September, 1960, mating and were joined with 116 cows.

Thirty-four selected heifers were joined with the top sire "Daymar Sinner" in 1959 and 30 calves were born, 2 of which died before marking. Of the 11 bull calves born, 8 were retained as future herd bulls. This mating was repeated in 1960 and at 30th June, 10 bull calves and 2 heifers had been born. A second bull breeding group using "Russley Cavalier" was established in 1960 with 20 selected cows, and 2 bull calves were born by 30th June.

The whole herd was tested for tuberculosis with negative results and the breeders, heifers and bulls were bled twice for agglutination test for brucellosis, again with negative results.

Losses during the year are shown in Table 15.

TABLE 15.—LOSSES IN CATTLE, BAIYER RIVER, 1960-61.

Cause of Loss.	Male.	Female.
Death, accidental and natural	8	26
Distocia	..	2
Culls killed for pig rations	..	7
Rations, Station and Mount Hagen	22	27
	30	62

The majority of deaths, accidental and natural, were in old breeders which had been culled from the breeding herd.

The first distribution of heifers to Native cattle projects was carried out with the sale of six heifers to the pilot projects in the Eastern Highlands. Forty heifers were held on the Station for future distribution.

The supply of meat to Mount Hagen and for Station rations was handicapped by the continual breakdown of the freezer. There were eight months of the year when beef could not be supplied.

HORSES.

Horses were bred for stock work. The blood stallion "High Adventure" was transferred to the Station during the year and was mated to several mares. He was severely affected by recurrent attacks of under-run soles and was out of action for several months. His first foals are expected in July, 1961.

SHEEP.

The flock was disbanded during the year, the sheep being killed for rations.

PIGS.

The pigs were transferred to the Station to utilize offal from slaughterings. The results of breeding have been disappointing, with one of the boars reluctant to serve and several of the sows failing to conceive after repeated services. The natural increase from six sows was sixteen. All the piglets were sold to local New Guineans.

CAPITAL IMPROVEMENTS.

New buildings constructed during the year included a single overseer's residence of 8 squares, dairy 25 ft. x 30 ft. and grain stores 60 ft. x 20 ft. The Station is now excellently improved so far as buildings are concerned, the buildings all being of permanent materials, mainly timber milled in the Station sawmill.

The homestead yards were maintained in good condition. They include a Cooper spray race and a large killing house. Outstation yards were also improved with installation of concrete-floored crushes.

PASTURE IMPROVEMENT AND CROPS.

Pasture improvement was speeded up considerably during the year as a result of the delivery of two new Massey Ferguson 65 tractors to replace the old John Deere and T.E.A. model Ferguson.

Four hundred acres was planted out bringing the total improved pasture to 600 acres and 300 acres of ground was prepared for further planting. Elephant, Guinea, molasses and para are the main grass species and centro, phasey bean and glycine have been used in conjunction with them.

The improved pasture areas have proved most valuable for the grazing cattle. Weaners have shown little setback and pregnant and lactating cows have held excellent condition on these pastures. The advantages of these introduced species over the natural grasses are obvious and the extension of improved pasture areas will be carried out as rapidly as possible.

Approximately 105 acres of sorghum for grain was planted during the year, the 30 acres harvested yielding 15 tons of grain. Inclement weather caused heavy losses.

The yield of 8 tons of grain from 50 acres of maize was disappointing.

ANIMAL INDUSTRY CENTRE, KURAKAKAUL.

The area of the Station has been reduced to 320 acres, of which 180 acres is reasonably flat, although not in contiguous areas, and 140 acres comprises low hills rising to steep hills at the rear. The Station acts as a Quarantine Station for the New Guinea Islands Region and a base for the Veterinary Officer and Stock Inspector. It runs a herd of Jersey cattle, stud Berkshire pigs and a small number of horses.

LIVESTOCK.

The livestock on the Station at 30th June, 1961, are shown in Table 10.

CATTLE.

A grade Jersey herd is held, together with a small number of Jersey cross heifers. The cattle were all in good condition and have given negative results to tests for tuberculosis and brucellosis.

Twenty-six calves were born during the first half of the year but calving fell away to only nine head in the latter half of the year. There were several returns to service although most cows and heifers now appear to be in calf and will calve out in the coming year.

With the completion of the construction of the dairy the cows were milked twice daily. Records of morning and evening milkings were taken at fortnightly intervals and selection within the herd will be based on these records.

It is planned to introduce Sahiwal blood in an attempt to produce a crossbred dairy animal suitable for the area.

PIGS.

The stud Berkshire pigs were run under intensive husbandry conditions as on other Stations.

Fifty-six piglets were born to six sows, an average litter size of 9.3. These litter sizes were encouraging but in the latter half of the year, there was an infertility problem in the sows. Some returned to service and the majority failed to farrow. The rations have been reduced to lower the condition of the sows in an attempt to get them in pig.

Selection within the group was based upon litter sizes and growth rate within litters.

HORSES.

The stallion "Prince Gaekwar" was used over all the Station mares, together with eight mares from private owners in the district, and one of his foals has been born on the Station to date.

CAPITAL IMPROVEMENTS.

One new Native married quarters was constructed.

A modern dairy was completed consisting of a 15 ft. x 15 ft. milk room, 6 ft. x 15 ft. engine room and 28 ft. x 15 ft. milking parlour equipped with a 4-stand Southern Cross milking machine. The bails were of tubular steel with dummy bails supported from the roof.

An indoor calf rearing pen was constructed, measuring 50 ft. x 30 ft. with half, comprising a feed room and two small pens, covered by a galvanized iron roof. The remaining area was divided by a feed rack. Water reticulation was carried out and provides fresh water under pressure to all parts of the dairy and calf pen.

A second piggery was commenced in April, 1961, and will be utilized in experiments with crossbreeding of native pigs.

A new teasing rail of welded pipe construction was installed adjacent to the stallion yard and stable.

PASTURE IMPROVEMENT.

Extension of the areas of Guinea grass and elephant grass was continued, the former being increased by 70 acres and the latter by 10 acres. Two acres of buffel grass was also planted. The encroachment of weeds in established pastures was a problem and was combated with selective weedicides and inter-row cultivation.

CATTLE STATISTICS.

Cattle population statistics for Papua and New Guinea are shown in Table 16, while Table 17 summarizes cattle sales from Divisional livestock stations in 1960-61.

TABLE 16.—CATTLE POPULATION, TERRITORY OF PAPUA AND NEW GUINEA.

District.	30th June, 1960.	30th June, 1961.	Increase.
Central	3,666	3,897	231
Northern	520	872	352
Milne Bay	550	550	..
Gulf	127	126	-1
Western	67	69	2
Southern Highlands	54	59	5
Total—Papua	4,984	5,573	589
Morobe	5,000	6,462	1,462
Madang	2,168	2,259	191
Eastern Highlands	1,220	1,436	216
Western Highlands	1,855	2,151	296
Sepik	340	465	125
Manus	159	160	1
New Britain	1,184	1,143	-41
New Ireland	409	450	41
Bougainville	159	114	-45
Total—New Guinea	12,494	14,640	2,246
Total	17,478	20,213	2,835

TABLE 17.—SALES OF LIVESTOCK FROM DIVISIONAL STATIONS, YEAR ENDING 30TH JUNE, 1961.

Category.	Stores.	Breeders.	Total.	Revenue.
Cattle	70	76	146	£ 4,431 16 0
Pigs	..	349	349	3,958 0 0

Figures do not include stock sold with the property at Arona.

DIVISION OF PLANT INDUSTRY.

Much of the work of the Division of Plant Industry is essentially of a long term nature but some of the salient points for the year may be summarized as follows:—

- (i) As a result of trials at Keravat which have been in progress for a number of years the Department has changed its official recommendation for cacao spacing from 15 feet on the equilateral triangle, which has been recommended hitherto, to 12-ft. triangular spacing.
- (ii) Clonal cacao trials at Keravat have been disappointing. As a group the overall performance of selected clones is little if any better than that of a stand of seedling cacao at an equivalent age. It seems that selection has done little more than sample a cross section of the population. However, the best clones are at least twice as good as average so that a limited number of selections will still be worth propagating.
- (iii) Trials with different methods and rates of application of potash to coconuts gave hope that an economic application might be found for mature palms. The application of potash to seedling palms in deficient areas had already been shown to be worthwhile.
- (iv) The compilation by the Principal Pathologist of the Check List of Territory Diseases was terminated at 30th June, 1960. The list will be published shortly with further addenda as required.
- (v) In addition to a number of detailed surveys, a reconnaissance survey was made of approximately 660 square miles of country not previously investigated in the Southern Bismarck range around Okapa.
- (vi) Serious attacks of defoliating caterpillars on young commercial cacao plantings were only partly brought under control and further investigation of these outbreaks is needed.
- (vii) The termite *Mastotermes darwiniensis* was recorded in Lae township. This discovery is of great importance as it is the first time that the species has been recorded outside Australia. In a suitable ecological niche, it is considered to be the most destructive of all termites. An eradication programme is planned.
- (viii) The suspected sulphur deficiency in tea at Garaina was confirmed by chemical analyses and field trials. Marked growth responses to sulphur application were obtained.

The reports of the Experiment Stations conducted by the Division of Plant Industry and the specialist sections of the Division are given below.

LOWLANDS AGRICULTURAL EXPERIMENT STATION, KERA VAT.

CACAO BREEDING.

OPEN-POLLINATED PROGENY TRIALS.

Block 304.—This was the first progeny trial planted, the seed being sown in the nursery in December, 1947, and seedlings transplanted to the field in March, 1948. The material consisted of progenies of ten mother trees selected from Asalingi plantation in the Bainings District of New Britain, and these parents were numbered KA1 to KA11 (excluding KA3).

Detailed yield records of all trees from first bearing up till 1958 showed marked differences between progenies. Mother trees were selected on the basis of early yields for use in clonal and breeding work. However, loss of trees through root rot has been particularly high in this block, and by 1958, the proportion of losses was so high that there was little value in continuing yield records. The high losses were probably related to the previous history of the block, as the pre-war cacao was cut out during the Japanese occupation and the area planted to food gardens, and after the war self-sown *Leucaena* was thinned for replanting.

A survey during this year of the number of missing and non-bearing trees showed that 15 per cent. were missing or represented by small replacement seedlings and a further 2.5 per cent. were replacements that were not bearing or at least had not grown into satisfactory

trees. Records showed that in ten years up to 30th June, 1958, 16 per cent. of the original trees had been replaced, though many of these replacements had been made early enough to make good growth. However, in the two and a half years between 30th June, 1958, and 31st December, 1960, a further 10 per cent. of trees had died. Thus the rate of losses has greatly increased.

Block 405.—This block was planted in 1948 and included four replicates of progenies of eighteen Keravat mother trees. Yield records have been maintained from the time the block began bearing at a reasonable level. This block was not planted to cacao pre-war, and losses have not been so high as in Block 304. A survey in December, 1960, showed 8 per cent. of the trees to be missing or non-productive.

Average yields of the block as a whole have been (in lb. dry cocoa per acre):

1953-54	..	..	..	650
1954-55	..	..	..	1,107
1955-56	..	..	..	653
1956-57	..	..	..	1,252
1957-58	..	..	..	594
1958-59	..	..	..	1,030
1959-60	..	..	..	1,644
1960-61	..	..	..	1,261

Mean yield 8 years 1,030 lb. per acre.

The sharp increase in yield in 1959-60 was largely attributable to shade reduction in a shade trial which was superimposed on the block in 1958 (*see under "Cacao Agronomy"*).

During the past year, pods were harvested and processed separately for each progeny to assess the number of pods and beans required to make a pound of dry cocoa. This assessment will need repeating to check its accuracy, but it is at least an indication of the comparative values for different progenies. These figures, together with average yields for an eight-year period, are shown in Table 18.

TABLE 18.—OPEN-POLLINATED PROGENY YIELDS IN BLOCK 405.

Progeny of—	Beans per lb.	Pods per lb.	Average Yield 1953-61.	
			Pods per Acre.	Lb. per Acre.
K6	355	9.3	15,848	1,704
K23	349	10.6	14,019	1,322
K25	320	9.5	12,072	1,271
K12	349	10.5	13,235	1,260
K26	299	9.1	10,175	1,118
K13	360	10.8	11,957	1,107
K20	366	10.7	11,318	1,058
K19	378	12.0	12,636	1,053
K24	344	9.0	9,407	1,045
K17	375	10.9	11,324	1,038
K5	405	11.8	12,088	1,024
K11	375	11.2	11,320	1,011
K16	375	10.6	10,112	954
K27	339	9.2	8,710	947
K21	315	10.2	9,035	886
K14	344	9.7	8,457	872
K9	339	10.4	8,692	836
K10	347	11.4	4,573	401

Block 506.—This block was planted in 1949 with eight replicates of ten progenies. The replicates of the progenies were used as plots for a shade and spacing observation trial. This aspect is discussed under "Cacao Agronomy".

As in Block 405, there were marked differences in yield between progenies, both in number and in size of pods. It was also noted that there have been differences between progenies in mortalities of trees, death rate being very high in one progeny particularly. Percentage deaths have been:

K23	14.5 per cent.	K28	9.0 per cent.
K24	10.5 per cent.	K29	2.0 per cent.
K25	13.0 per cent.	K30	1.5 per cent.
K26	29.0 per cent.	K31	6.0 per cent.
K27	11.5 per cent.	K32	5.5 per cent.

L.S.D. 5 per cent. = 8.0 per cent.

1 per cent. = 10.6 per cent.

Pod values and bean weights assessed during the year are shown in Table 19.

TABLE 19.—POD VALUES OF PROGENIES IN CACAO BLOCK 506.

Progeny of—							Beans per lb. Dry Cocoa.	Pods per lb. Dry Cocoa.
K23	..	..	..	..	..	..	337	12.1
K24	..	..	..	..	..	..	350	9.9
K25	..	..	..	..	..	..	333	10.0
K26	..	..	..	..	..	..	324	12.2
K27	..	..	..	..	..	..	327	9.5
K28	..	..	..	..	..	..	344	10.6
K29	..	..	..	..	..	..	351	10.7
K30	..	..	..	..	..	..	339	12.7
K31	..	..	..	..	..	..	379	10.2
K32	..	..	..	..	..	..	370	10.4

PROGENY-TESTING—BLOCKS 106, 107, 108 AND 3010.

Little further comment can be made on the material in these blocks, which serve mainly for observation. Some of the selfed lines show extreme stunting, which may be a result of general lack of vigour or perhaps of harmful recessive genes in the homozygous state.

POLLEN DISPERSAL TRIALS.

Unfortunately it was not possible to strike sufficient clonal material for the plots in these trials so that they could be fully planted at one time and all trees would mature together. Thus, although some pods have been harvested from all plots, many trees in each are not yet bearing.

Trial A.—Two pods were harvested from KT14, the white self-compatible surround, and all beans were pure white. Since the KT82 marker row was not yet flowering, this conformed to expectation.

Trial B.—Part of the KT82 purple surround has matured ahead of the KT14 white marker row. In all 40 pods harvested up to 30th June, the bean colour was consistent with their having been self-pollinated. Quite a large proportion of the beans cut were brown and dead as if fermented. This has not been noted in other clones and was not found in older material of the same clone, and it appears that it may happen only in the first few pods set on each tree.

Trial C.—A marker line of self-compatible KT82 (purple) is surrounded by self-incompatible KT8 (white). The KT8 on one half of the plot was mostly mature and the KT82 marker produced some ripe pods from May, 1961.

It had been anticipated that no pods would be set on KT8 until such time as pollen was available from the marker line, but mature pods were harvested from KT8 in August, 1960, at a time when it appeared most unlikely that KT82 had been flowering. Cutting the beans

confirmed that KT82 was not the parent. Since then 57 pods have been harvested from KT8, and only a small proportion had the uniform violet beans expected from KT82 pollination. Some pods contained only pure white beans and others showed a range of shades between white and violet. At first it was suspected that a stray cutting of some other clone may have been planted by mistake amongst KT8, but careful examination has not shown any sign of a foreigner. Moreover, the variability in bean colour suggested that several pollen parents were involved. In many of the twenty pods harvested from the KT82 marker line, the bean colour was not entirely uniform (either pure dark break from selfing, or uniform medium break from the KT8 cross had been expected), suggesting mixed pollination, although the mixture could simply have been KT8 with KT82.

The only possible conclusion seems to be that pollen has been carried to the plot from mature cacao growing on the main Station. Since the nearest cacao is a full half mile distant through dense bush, this would necessitate the pollinating insect travelling (or being carried) very long distances.

CACAO AGRONOMY.

SHADE x SPACING TRIAL—BLOCK 506.

The plots at 12-ft. spacing maintained slightly higher yield than those at 15 feet while the yields of the unshaded plots were about equal to those with shade. This latter result was probably influenced by the effects of a fertilizer trial with urea which has been superimposed on the block since 1958. The fertilizer appears to have caused a yield improvement only on the unshaded plots, although the differences have not been statistically significant. Hence the comparison of unshaded with shaded plot yield may no longer be valid.

Yields of the fertilizer trial are shown in Table 20. Further details of this trial are discussed in a paper "Spacing and Shading of Cacao" which will appear shortly in the *Papua and New Guinea Agricultural Journal*.

TABLE 20.—FERTILIZER TRIAL ON SHADED AND UNSHADED CACAO.

				Number of Pods Harvested.			
				No Shade Control.	No Shade + N.	Shade Control.	Shade + N.
Pretreatment yield 1957-59	..	..	..	36,574	38,616	44,094	41,822
Yield 1959-60	..	..	..	28,520	34,828	29,084	26,749
Yield 1960-61	..	..	..	18,766	24,164	21,936	20,995

SHADE TRIAL—BLOCK 405.

As in the previous year, yields showed a negative correlation with shade level. Results of this trial also are discussed in the paper mentioned above.

SEEDLING SPACING TRIAL—BLOCK 2010.

Most of the trees in the triangular spacing plots were bearing by the end of 1960, and yields were collected for the period up to December, 1960. These showed a positive correlation of 0.995 between yield and number of trees per acre. Detailed results are given in the paper mentioned above.

Trees in the hedge spacing plots commenced to bear late in 1960, and yields will be summarized at the end of 1961. In these plots there is a line beneath the trees where weeds are eliminated through shading and leaf fall, but there is still some weed growth between the lines. In cacao of the same age at 12-ft. triangle spacing, which was planted to fill in odd corners around the trial block, weed growth is completely eliminated.

SPACING x PRUNING TRIAL—CLONAL MATERIAL.

Two clones were used in this trial, the plot trees being KA5.104, and surrounding guard trees K26. These clones were chosen for their distinctive pod types, so that in harvesting it would be simple to distinguish them. The guard trees are given the same treatment as the plot trees, and guards are sufficiently wide to ensure that no appreciable edge effect will occur in the plots. Yield records are kept on the KA5.104 plot trees only.

In the first few months' yield recording (up to October, 1960) an error was made and yields of two of the hedge plots were confused. However, yields up to this date had been quite small, and further yields have therefore been kept separate. Yields from November, 1960, to June, 1961, were:

9 ft. triangle	..	5,840 pods per acre	..	9.4 pods per tree
11 ft. 6 in. triangle	..	3,954 pods per acre	..	10.4 pods per tree
14 ft. triangle	..	4,900 pods per acre	..	19.1 pods per tree
18 ft. x 6 ft. hedge	..	5,589 pods per acre	..	13.9 pods per tree
18 ft. x 4 ft. hedge	..	4,797 pods per acre	..	7.9 pods per tree

The trial was planted on a rather long narrow block of land, and unfortunately this has proved unsatisfactory for assessing pruning effects on yield. A pronounced gradient in yield from one end of the block to the other has shown up, and as the pruning *v.* non-pruning effect is mostly in the same direction, it is impossible to separate the effects. It is hoped that this yield gradient may pass off as the trees age—similar gradients in early yield in one or two other blocks have disappeared with time.

The effect of pruning on habit and accessibility in the early stages proved to be rather short-lived. Only fairly light pruning was given, and it was found that new growth soon replaced much of what had been taken off and also higher branches tended to droop once lower ones had been removed. Accessibility seems to be improving slightly as the trees age, owing to lower limbs being shaded out, and observations in older clonal blocks indicate that this trend will continue. Because of the short-lived effect of the earlier light prunings, much more severe pruning is to be practised in future, all low limbs being cut right out.

HYBRID SEED DEVELOPMENT—BLOCK 309.

The cacao improvement programme at Keravat has been carried out along three lines concurrently:

1. The vegetative propagation of desirable trees.
2. The development of "clonal" seed.
3. The development of hybrid seed.

The last-mentioned of these is the longest-term approach and involves a programme of selection and breeding extending over a number of generations. The stage has now been reached where the hybrid seed has been produced (by hand-pollination) and seedlings planted out in Block 309. There are 48 different crosses, involving 34 selected clones and 14 inbreds as parents. These parents were selected within two groups, Criollo or near-Criollo and Forastero or near-Forastero, and both like and unlike crosses have been made as shown below:

		Self-compatible.	
		Criollo.	Forastero.
Self-Incompatible	Criollo	C X C	C X F
	Forastero	F X C	F X F

Twelve of the male parents were selected clones and twelve first-generation inbreds. Only two female parents were inbreds and both of these were self-compatible also.

The trial will test 48 specific crosses and will also test the generalization that crosses between unlike parents are superior to crosses between like parents. Unfortunately, the seed of all crosses was not available at the same time so that there is 18 months difference in age between certain seedlings. However, as the trial ages, this will become less and less important. The oldest seedlings are only 21 months old so it will be some time before results will be forthcoming from this trial.

Hybrid seed gardens are being established concurrently with the testing of this seed and 600 cuttings have been planted in three gardens, each of which is isolated from all other cacao. Each of the crosses used is represented in Block 309 also, and the same policy will be followed in future gardens so that the seed of a number of crosses will be available as soon as results are forthcoming from 309.

The design of these hybrid seed gardens is set out below:

x	0	x	x	x	0	x	x	x	0	x
x	0	x	x	x	0	x	x	x	0	x
x	0	x	x	x	0	x	x	x	0	x
x	0	x	x	x	0	x	x	x	0	x
x	0	x	x	x	0	x	x	x	0	x
x	0	x	x	x	0	x	x	x	0	x
x	0	x	x	x	0	x	x	x	0	x
x	0	x	x	x	0	x	x	x	0	x
x	0	x	x	x	0	x	x	x	0	x
x	0	x	x	x	0	x	x	x	0	x

0 = self-compatible pollen source.

x = self-incompatible seed source.

CLONAL SEED GARDENS—BLOCKS 209 AND 308.

As explained in last year's report, "clonal" seed gardens have been established at Keravat as a quick means of producing superior seed. There is as yet no guarantee that any particular cross will produce improved seed but the parents have been selected on the basis of past yields and it is hoped that the average of all crosses will be superior to bulk seed. Most of the 65 gardens established are now bearing and any one order for seed is filled by taking pods from a number of gardens rather than from one or two.

The design of the earlier-planted gardens was not all that might be desired, owing to a scarcity of self-compatible clones, and it is possible that seed harvested from the self-incompatibles may be the result of crossing with a self-compatible other than the one intended. In the later gardens, lines of a number of self-incompatibles have been surrounded completely by the self-compatible pollen source and each series has been separated from the next by a few rows of a self-incompatible clone. It was thought that this would be sufficient guarding to prevent the entry of pollen apart from that intended, as the main concern was about pollen from the self-compatibles in adjacent gardens. However, results now available from pollen dispersal trials suggest that pollen can be carried much further than was originally thought. This being so, it would seem that each series of self-incompatibles plus the self-compatible surround would need to be well isolated from all other possible pollen sources to ensure that only the cross desired would take place.

There is also a possibility that crossing is occurring between the self-incompatibles within a series of gardens. Should this be so then some of the pods harvested may be the result of a S.I. x S.I. cross and not the S.I. x S.C. cross intended. This may or may not be of importance from the point of view of supply of improved seed as the cross which occurs may produce seed of the same quality as the cross intended. Should the incompatibles be crossing with one another, then the seed from these gardens would be of limited value for planting in progeny testing blocks where the object was the evaluation of a particular cross. Furthermore, it would become difficult to ensure that seed used to test a specific cross, whether obtained by hand crossing or by natural pollination in the field, would adequately represent the type of seed which would be obtained from a seed garden of commercial size established with the same parents.

Hand pollinations have begun with the aim of establishing to what extent, if any, crossing between self-incompatibles may occur. The first step was to pollinate a certain number of flowers on each of the self-incompatibles in a series with pollen from a self-compatible. The two self-incompatibles which register most takes will be used as the females to be pollinated by each of the other self-incompatibles. Selection of these incompatible females was deemed advisable because of the difficulty of getting pollinations to take on certain clones quite apart from the incompatibility reaction. If crossing between self-incompatibles does occur naturally and is to be demonstrated by hand-pollination, then as many barriers to successful cross-pollination as possible must be removed.

CLONE TESTING.

The vegetative propagation of desirable trees is the most straightforward approach to improvement. The value of selected phenotypes has to be confirmed by testing which is being carried out in the Clone Testing blocks. These consist of five series each involving thirteen clones (four self-compatible and nine self-incompatible) with one self-compatible common to all series. A sixth series was designed to test self-compatibles only and comprises six clones, one of which (K5) is the bridge between all series. All told, 63 clones are being tested, 20 self-compatibles and 43 self-incompatibles.

The first series was planted in March, 1956 and the last in December, 1958. All series have commenced bearing, the average time taken to do so being two years three months. Series I has been yield recorded for three years and the yields of the thirteen clones are given in Table 21.

TABLE 21.—CLONE TESTING SERIES I. YIELDS IN POUNDS OF DRY COCOA PER ACRE UP TO 31st MARCH, 1961.

COMPATIBLES.							
K50	..	..	..	1,941			
KT82	..	..	..	1,544			
K5	..	..	..	1,189			
K52	..	..	..	481			
INCOMPATIBLES.							
KA5-104	..	..	2,571	K21	..	..	1,360
K27-102	..	..	2,260	K23-105	..	..	1,070
K16-101	..	..	1,786	KA2-105	..	..	1,042
K24-103	..	..	1,647	K12-101	..	..	699
K11-101	..	..	1,385				

Compatible mean = 1,289. Incompatible mean = 1,536.

These results indicate considerable variation in yield from clone to clone and suggest that the criteria used for selection have been ineffective. The variability and the mean yield of all clones are comparable with the variability and mean yield of a good stand of seedling cacao of the same age. Thus, while it was hoped that the majority of the selected clones would be superior in yield to seedling cacao, it appears that they are merely a cross-section of the population.

On the basis of the above results, the number of clones for distribution for commercial planting has been reduced from 22 to ten. Also, clones discarded in the past are being re-examined as it is possible that some with a satisfactory yield have been discarded on secondary characteristics only, in the belief that most of the selections would be high-yielding and that severe selection for secondary characteristics could be carried out.

In each of the first five Clone Testing Series, six-tree plots of each of nine self-incompatible clones are replicated four times, the surrounding self-compatible in each replicate being a different clone. Thus, these trials will also indicate the influence of male parentage on flavour and cocoa butter content by comparison between identical self-incompatible clones from each replicate. Some flavour and cocoa butter determinations have already been made on the clones in Series I but the number is not yet sufficient to warrant definite conclusions.

The seed from the incompatibles in each series is being used to fill cacao seed orders where necessary, seed from 36 different crosses being available from each series.

In order to convert pod counts to actual yields, pod value determinations were carried out on each of the clones in Series I, pod value being the number of pods required to produce one pound of dry cocoa beans. Beans from each clone were fermented in net bags inside a bulk ferment, dried, weighed and counted. The pod value and the number of beans per pound could then be calculated. These determinations have been made twice in the last twelve months and further figures will be necessary before a reliable mean can be worked out for each clone.

CACAO FERMENTATION.

The "new technique" for fermenting cacao referred to in the Annual Report for 1959-60 has been subjected to a proving period of two years beginning in May, 1959. Whenever possible during this period, a direct comparison was made between this technique and the old technique. The results at Keravat to date have shown no distinct advantage of the new technique over the old. Both methods have proved to be reliable and capable of producing

beans of good quality, but neither was consistently superior in terms of strength of chocolate flavour or with respect to off-flavours introduced. It would appear, therefore, that under Keravat conditions and with the type of bean produced there, the old technique is satisfactory. Growers in other localities who find the old technique unreliable may find the new technique more consistent.

Experiments concerned with establishing a weight per cubic foot of beans as the criterion to use to define the end of the resting phase were largely inconclusive, owing mainly to the difficulty of getting consistent results for weight per cubic foot. Two types of boxes were used, one with internal measurements of 1 ft. x 1 ft. x 1 ft. and the other 4 ft. x 6 in. x 6 in., but repeatability of results was poor with both, regardless of the method of packing.

The density of beans on the resting floor originally recommended was 1 cubic foot of beans to 10 square feet of floor space, approximating the normal density of beans placed on a sun-drier to dry, and other details of the method were then worked out on this basis. In the hope of reducing the size or number of resting floors required, the thickness of the layer of beans during the resting phase has been increased experimentally. Densities of 1 cubic foot of beans to 5 square feet of floor space and 1 cubic foot to 6.6 square feet of floor space, together with a suitably increased resting period and increased number of stirrings, have proved completely satisfactory. In fact, both usually produced beans slightly superior to those from the standard resting procedure in terms of strength of chocolate flavour. The fact that a higher density of beans may be used during the resting phase greatly reduces the capital cost of installing resting floors.

The state of the mucilage of the fresh beans, weather conditions and other factors will combine to make it difficult to recommend a procedure which will be best under all conditions. However, the most suitable recommendation for a resting phase, where it is found to be advantageous, appears to be that a density of 1 cubic foot of beans to 5 to 6.6 square feet of floor space be used with a resting period of ten hours and five or six stirrings.

VEGETATIVE PROPAGATION.

The method of cacao propagation previously developed on this Station is still being employed. Glass covered propagating boxes are used with well-leached sawdust as the striking medium.

The present wooden nursery house is to be replaced with a larger and more permanent structure incorporating galvanized iron piping and nylon shade cloth. Demand for clonal material is growing but the proposed structure with a capacity of up to 80,000 plants a year will make it possible to meet this demand.

It is hoped also to find longer lasting materials for the propagating boxes as the 6 x 1 inch hardwood now used breaks down quickly and breakages of the glass covers occur frequently.

The following striking techniques employed overseas have recently been tried at Keravat:

Marcotting.—A ring of bark is removed from a semi-hardwood shoot approximately 1 foot from the tip, and the wound and bark 1 inch on either side of the wound are painted with a root-inducing hormone, covered with a pad of moist sawdust in a ball of coconut fibre, tied firmly, then covered with a piece of polythene sheet which is tied securely at each end.

T Budding.—The method established by Mr. G. F. Topper has been followed. An inverted T cut is made near the base of a seedling and a shield approximately 1½ inches long taken from a mature terminal branch is inserted into the cut, the wound then being bound with plastic budding tape.

Continuous Mist.—Cuttings are rooted either in containers or in beds, taking advantage of the completely saturated atmosphere induced by the continuous mist. Usually the mist is stopped at night.

Plastic Bag Technique.—Cuttings are completely enclosed within a plastic bag after the base has been treated with root inducing hormone and wrapped in a core of sawdust and coconut fibre. The fibre is held in place either with string or with an elastic band. The bag is then suspended in a situation where from 12 to 15 per cent. light is obtained.

Marcotting and the plastic bag technique in particular need serious consideration, for both are simple and cheap, do not require elaborate structures, and would not be beyond the means of planters who wished to produce their own clonal material.

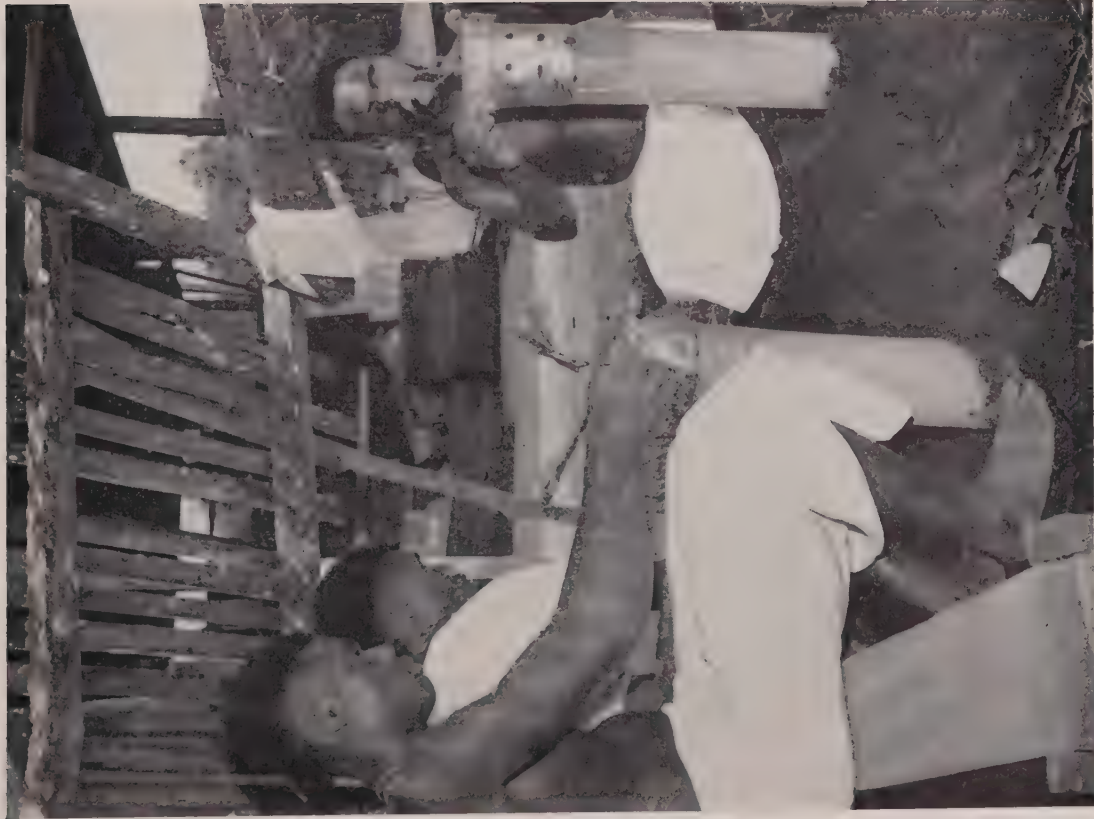


Plate 5—Polythene bags are supported in galvanized iron tubes during filling and transplanting of cacao cuttings.
[Photo : D.I.E.S.]



Plate 6—Cacao cuttings grow well in polythene bags, which are economical of space.
[Photo : D.I.E.S.]

Papua.

Black Sand.—This trial continued to give no clear yield response. The possible nitrogen effect disappeared at the October, 1960, count, but reappeared in April, 1961. This may have been a real fertilizer effect, as the regular nitrogen application had been omitted in April, 1960, but was repeated in October, 1960. Nut counts were as follows:

Treatment.							10/60.	4/61.
No N	..	..	..	..	..	..	33	32
N	..	..	..	..	..	..	33	38

Although the whole block of palms showed improvement in appearance relative to surrounding palms, it was found at these two observations that within the block the nitrogen fertilized palms looked slightly better than those not receiving nitrogen. To test the effectiveness of nitrogen, six palms close to the trial block, all of which showed marked yellowing, were each given 3 lb. sulphate of ammonia in October, 1960. However, no response was evident six months later.

Further studies will be continued on this area, but there seems to be no advantage in continuing the trial in its present form.

Alluvial Brown Loam.—Further yield records have not shown any appreciable response in this trial. The possible response to minor element treatments did not show up further. Numbers of nuts per palm for this treatment have been as follows:

Treatment.							10/60.	4/61.
No minors	..	..	..	..	..	..	34	33
Minors	..	..	..	..	..	..	32	30

The trial will not be continued further, but another trial is planned for seedling coconuts growing on this soil type (to be superimposed on the replanting trial). Response will be judged initially on the growth of the seedlings, and will also be followed through foliar analyses. Pretreatment foliar analyses have already been made.

SPECIFIC FERTILIZER TRIALS.

New Ireland.

Potash Rate of Application Trial.—Yield records up to December, 1960, have been analysed, and plot yields, adjusted by covariance analysis for pretreatment yield, are shown in Table 23. The plots contain an average of twelve trees each.

TABLE 23.—POTASH RATE OF APPLICATION TRIAL.
NUMBERS OF NUTS PER PLOT (ADJUSTED FIGURES).

Treatment.					6/59.	12/59.	6/60.	12/60.
0	..	..	..	..	181.6	177.8	167.4	132.9
2½ lb.	..	..	..	..	221.6	231.0	273.4	234.0
5 lb.	..	..	..	..	196.5	233.4	270.4	284.7
10 lb.	..	..	..	..	195.8	214.0	283.6	304.9
Least significant difference 5 per cent. level					42.5	56.7	81.7	55.1

Records for June, 1961, have not yet been analysed, but whereas the response of the 2½ lb. treatment remained constant, the 5 lb. and 10 lb. treatments both declined relative to the control. While the causes of this need further study, for the present it appears that the lighter dressing (2½ lb. per palm) may be the most promising economically.



Plate 7—*Interplanting of mature coconut palms with cacao has been very successful on suitable soils.*

[Photo : D.I.E.S.]



Plate 8—*Vigorous young palms just mature enough for interplanting.*

[Photo : D.I.E.S.]

Nuts were collected and copra weights taken in June, 1961, to find whether the fertilizer had improved nut size. No appreciable difference was found between treatments, but insufficient nuts were available for these results to be reliable.

Fertilizer applications were repeated in December, 1960.

Potash Method of Application Trial.—Yield records up to December, 1960, have been analyzed, and plot yields (adjusted by covariance analysis for pretreatment yield) are shown in Table 24. The plots contain an average of eight trees each. All treatments total 2 lb. per palm per year (see Annual Report 1959–60 for details).

TABLE 24.—POTASH METHODS OF APPLICATION TRIAL.
NUMBERS OF NUTS PER PLOT (ADJUSTED FIGURES).

Treatment.	6/59	12/59	6/60	12/60.
(i) Control	151.2	135.6	128.1	134.6
(ii) Narrow band, biennial	154.9	153.6	174.4	219.5
(iii) Broad band, biennial	166.1	179.8	201.6	223.0
(iv) Broad band, annual	166.7	182.8	175.9	219.7
Least significant difference 5 per cent. level ..	33.4	45.8	36.4	46.6

Records for June, 1961, have not yet been analysed, but the responses to treatments (iii) and (iv) have been maintained at the same level, while treatment (ii) has declined relative to the control.

Fertilizer applications were repeated in December, 1960.

Potash Fertilizer Trial with Seedlings.—A further application of 8 oz. muriate of potash per seedling was made in December, 1960.

Measurements of growth were made in December, 1960, and May, 1961. The method of measuring height had to be altered in May, 1961. Previously the height recorded was measured from the ground to the tip of the tallest leaf, straightening the leaf to its maximum length. However, many seedlings are now too tall for this, and the height was recorded by standing a scale beside the leaf without straightening it. Thus the measurement tends to be smaller, and perhaps somewhat less accurate. An additional measurement was also made at this time, namely leaflet weight. Two leaflets were taken from the centre of the youngest fully opened frond; leaflets from each plot were bulked and weighed (fresh weights). This measure is at this stage a rather more sensitive measure of growth than is height. Results are summarized in Table 25.

TABLE 25.—POTASH FERTILIZING OF SEEDLINGS, NEW IRELAND.

Treatment.	Number of New Leaves.			Height (in.).		Leaflet Weight (gm.).
	12/60.	5/61.	6/59 to 5/61.	12/60	5/61.	5/61.
No K	2.28	3.23	13.40	80	85	7.2
K	2.37	3.46	14.38	103	120	11.8

The advantage of the fertilized seedlings over the unfertilized has steadily increased, except in the number of leaves produced. Taking leaflet weight as the most reliable index of seedling size, the fertilized plants are now more than 60 per cent. larger than the unfertilized.

Chemical analysis of leaflets again showed the uptake of potash in the fertilized plots, average potash content of untreated seedlings being 0.99 per cent., treated 1.65 per cent. in December, 1960; untreated 1.39 per cent. and treated 1.99 per cent. in May, 1961.

New Britain.

Nitrogen-Phosphorus Trial on Interplanted Cacao/Coconuts.—This trial is of immediate importance in the industry, where appreciable quantities of nitrogenous fertilizer are now being used on interplanted coconuts and cacao. A good interplanted stand is illustrated in Plate 7.

Rates of fertilizer in this trial were increased from July, 1960, nitrogen now being used at three positive rates, namely $\frac{1}{2}$ lb., 1 lb. and 2 lb. urea per cacao tree, applied every six months. Superphosphate, which had shown no sign of response, was applied only in July, 1960, at the rate of $\frac{1}{2}$ lb. per cacao tree. The lowest nitrogen rate is about a third higher than the higher rate in the original trial.

Only one further count has been made on the coconuts, and this again failed to indicate any response. Average numbers of nuts per palm were: $N_0 = 35$, $N_1 = 37$, $N_2 = 34$, $P_0 = 35$, $P_1 = 36$.

The cacao yields in 1960 were low and response to fertilizer was neither very great nor statistically significant on a straight analysis of variance. The heavier rates in July, 1960, could have taken effect by early 1961, so that yields in 1961 might have been expected to reflect the higher rates. Once again, as in 1959, the earliest yields appeared to show a marked differential response which largely disappeared later. Pod numbers are shown in Table 26.

TABLE 26.—NITROGEN-PHOSPHORUS TRIAL IN INTERPLANTED CACAO/COCONUTS.
NUMBER OF CACAO PODS HARVESTED.

Treatment.						Total, 1960.	January/February, 1961.	January/June, 1961.
N_0 (now N_3)	..	..	..	..	..	15,785	755	13,827
N_1 (now N_8)	..	..	..	..	..	16,424	991	12,932
N_2 (now N_{12})	..	..	..	..	..	17,459	1,173	14,307
P_0	..	..	..	..	..	25,660	1,429	21,411
P_1	..	..	..	..	..	24,008	1,438	19,655

CULTIVATION.

Treatments in this trial are now control, annual strip ploughing in alternate rows, and six-monthly all-over ploughing. However, the effects of the new treatment, commenced in 1960, would hardly show up prior to 1961. Hence results are recorded against the original treatments in Table 27.

TABLE 27.—CULTIVATION TRIAL, PAPUA.
NUMBER OF NUTS HARVESTED.

Treatment.							1959.	1960.
Control	..	..	..	..	..	..	9,562	8,753
Harrow	..	..	..	..	..	..	9,157	8,805
Plough	..	..	..	..	..	..	9,448	8,557

REPLANTING.

Baibara, Papua.—Progress in this trial was fairly satisfactory, but there were set-backs to the seedlings from a number of causes, including damage by cattle, pigs, opossums and dynastid beetles, and patches of water-logging. Because of the large area covered by the trial, these factors have affected some plots more than others, and probably some treatments more than others. Some 35 per cent. of the original seedlings have been replaced since the commencement of the trial, and deaths have been more frequent in some treatments than others, as shown in Table 28. However, it is difficult to assess to what extent the differences were due to the treatments, though the lack of statistical significance possibly indicates that they were largely due to other effects.

TABLE 28.—REPLANTING TRIAL, BAIBARA.

Treatment.					Survival of Original Seedlings at April, 1961.	Total Number of Leaves per Seedling up to April, 1961.	Average Height of Seedlings (inches) at April, 1961.
					Per cent.		
No thin	..	..	..	..	77	18.7	104.4
$\frac{1}{4}$ thin	..	..	..	..	69	19.3	103.6
$\frac{1}{2}$ thin	..	..	..	..	61	20.4	101.7
$\frac{3}{4}$ thin	..	..	..	..	52	19.7	86.5
Full thin	..	..	..	..	64	21.8	106.0
Significance	..	..	..	..	N.S.	L.S.D. 5% = 0.8 1% = 1.1	N.S.

The only statistically significant difference between treatments so far was in the number of leaves formed, which was slightly higher where the old palms have been removed than where they remained. However, differences in height, which are probably a better index of vigour, were small and non-significant. As in the potash fertilizer trial on seedlings, the height measurement in April, 1961, was different from earlier measurements.

Nut numbers were counted only once during the year and indicated fairly definitely that thinning of the stand did not improve yield of the remaining palms. If anything, the reverse applied. Average numbers of nuts per palm in April, 1961, were:

No thin	..	42.0
$\frac{1}{4}$ thin	..	39.4
$\frac{1}{2}$ thin	..	34.1
$\frac{3}{4}$ thin	..	29.2

New Ireland.—Progress of seedlings in this trial was fairly satisfactory, although some damage was caused by dynastid beetles and leaf hispids. In respect of the latter, it was noticed that the seedlings in the unthinned and partially thinned plots were being colonized by the red ant (*Oecophylla smaragdina*) much more than in the plots from which old palms had been removed, and these ants gave fair control of the hispid beetles.

Measurements of seedling growth are summarized in Table 29. As mentioned under the fertilizer trial discussion, the method of height measurement was changed from May, 1961. Leaflet samples also were taken in May, 1961, and weights recorded.

TABLE 29.—REPLANTING TRIAL, NEW IRELAND.

SEEDLING GROWTH.

Treatment.					Number of New Leaves.		Average Height (inches) May, 1961.	Average Leaflet Weight (gm.) May, 1961.
					December, 1960.	May, 1961.		
No thin	..	..	..	..	2.2	3.2	96	77
$\frac{1}{4}$ thin	..	..	..	..	2.2	3.2	93	85
$\frac{1}{2}$ thin	..	..	..	..	2.3	3.6	114	114
Full thin	..	..	..	..	2.5	3.4	107	109

As in the Baibara trial, variability was very high and none of the differences significant.

A nut count in December, 1960, failed to show any increase in yield per palm in the thinned plots. Average numbers of nuts per palm were:

No thin	..	32
$\frac{1}{4}$ thin	..	36
$\frac{1}{2}$ thin	..	30

Unfortunately the precision of both these trials is low, but it does appear still that replant growth in the early stages is not greatly influenced by the presence of the old palms.

INTERPLANTING WITH CACAO.

Losses through *Oryctes* have continued and 63 more replacements were made during the year. This brings the total to 293 replacements to date in a plot of 315 trees, though many of these replacements have been repeated at the same point. Several of the original seedlings have reached the flowering stage, and one has produced two mature fruit.

Much of the *Oryctes* problem is thought to be a result of their breeding in a nearby block of oil palms, and a start has been made on removal of the palms.

IMPROVEMENT OF PLANTING MATERIAL.

PROGENY TRIAL.

The third replicate of this trial was fully planted again in September, 1959, this time with a reasonable rate of survival. The fourth replicate, however, has still only a few seedlings successfully established. The first two replicates are fairly well established, although up to April, 1961, a total of 100 replacements had been made at the 216 points in the plots. Some damage was caused during the year through cattle and pigs getting into the paddock, and the fence has now been made completely pig proof.

Germinations of the seed nuts are shown in Table 30 and growth of seedlings in Table 31. The growth measurements are based on the first two replications only. Differences in mortalities between progenies complicate the interpretation of the results, as the cause of death has sometimes been accidental and it is hard to judge to what extent the deaths should be taken into account in evaluating progeny performance. Accordingly, in Table 31, two sets of figures are given for leaflet weight. Those in column (a) are based on the total leaflet weights from each plot, divided by 12 (i.e. all trees in the plot are included regardless of age). In column (b) the figures are averages of only those seedlings planted before September, 1958. The average of new leaves produced and seedling heights are also based only on seedlings which were planted before September, 1958.

TABLE 30.—BAIBARA PROGENY TRIAL.

GERMINATION OF SEED NUTS.

Parent.					Number Planted.	Number Germinated.	Per cent. Germination.
B17	..	..	..	..	256	236	92
B5	..	..	..	..	177	157	89
B13	..	..	..	..	155	131	85
B4	..	..	..	..	189	154	81
B11	..	..	..	..	145	116	80
B12	..	..	..	..	128	101	79
B8	..	..	..	..	195	155	79
B10	..	..	..	..	245	184	75
B14	..	..	..	..	181	92	51

TABLE 31.—BAIBARA PROGENY TRIAL.

SEEDLING GROWTH.

Parent.					Number Replacements to April, 1961.	Number New Leaves September, 1959 to April, 1961.	Seedling Height (in.) April, 1961.	Leaflets Weights April, 1961. (gm.).	
								(a)	(b)
B4	..	..	..	..	8	13.2	157	1.3	1.7
B5	..	..	..	..	6	13.0	145	1.2	1.4
B8	..	..	..	..	12	13.4	124	0.7	1.0
B10	..	..	..	..	11	13.4	148	1.1	1.5
B11	..	..	..	..	11	13.0	132	0.9	1.2
B12	..	..	..	..	16	12.1	125	0.8	1.2
B13	..	..	..	..	8	12.5	122	0.9	1.1
B14	..	..	..	..	6	14.0	144	1.2	1.5
B17	..	..	..	..	22	13.1	107	0.5	0.8
Significance	..	..	..	..	N.S.	N.S.	N.S.	L.S.D. 5% = 0.2	L.S.D. 5% = 0.4



Plate 9—*A clonal seed garden of the Besoeki strain of robusta coffee.*

[Photo : D.I.E.S.]



Plate 10—*The Besoeki strain of robusta coffee bears heavily.*

[Photo : D.I.E.S.]

SEED SOURCES TRIAL, KERA VAT.

Seedlings in this trial have made good progress, although towards the end of the year there was rather extensive damage by dynastid beetles (all those collected having been *Scapanes*). *Brontispa* leaf hispid caused some damage but was controlled by dieldrin applications. Up to February, 1961, 12 per cent. of the original seedlings had required replacement.

Attempts were made to establish a *Pueraria* cover over the block, but only small patches have yet been covered. Further efforts will be made, as it appears that *Imperata* will take over if some better cover is not established.

Growth measurements were made on all seedlings in February, 1961, and results are summarized in Table 32. The leaflet weights were of four leaflets taken from the centre of the youngest fully-opened frond. The numbers of new leaves were for a period of six months.

TABLE 32.—SEED SOURCES TRIAL, KERA VAT.

SEEDLING GROWTH AT FEBRUARY, 1961.

Source.	Number of Replacements.	Number of New Leaves.	Seedling Height. (inches.)	Leaflet Weight. (gm.)
Papua	7	4.1	98.0	26.8
Karkar Is.	10	3.8	86.2	25.3
Madang	8	3.9	91.5	24.5
New Ireland	16	4.1	90.7	24.0
Markham	10	4.1	101.0	30.5
Bougainville	4	4.1	117.5	34.8
Hermit Is.	5	4.2	87.5	21.5
Sepik	3	4.2	97.2	28.3
Gazelle Pen.	4	4.6	103.5	28.3
Significance	N.S.	N.S.	L.S.D. 5% = 14.7 1% = 18.0	L.S.D. 5% = 5.2 1% = 6.4

As stated in last year's report, seedlings were classified in the nursery as "selected" or "reject", but all except the most stunted were transplanted. Performance of these two groups was compared in February, 1961, and it was found that 16.4 per cent. of reject seedlings had died as against 9.3 per cent. of selected seedlings; and average leaflet weight of the reject seedlings was 18.5 gm. as against 28.6 gm. for the selected seedlings.

CROSSING OF TALL AND DWARF PALMS.

One of the hybrid palms died during the year but the remainder made good growth.

POLLEN STUDIES.

Studies on pollen storage were continued but with very inconsistent results. Variations were tried in most of the factors involved, but as yet no satisfactory method either of storage or of *in vitro* germination has been found.

OBSERVATIONS AND SURVEYS.

LIGHTNING STRIKE.

No fresh strikes were reported and few observations were made. However, it was observed in connexion with a strike which occurred early in 1959 that one tree which showed early symptoms survived at least eighteen months before finally dying. A *Ganoderma* bracket was noted on the stem in November, 1960, when the palm was still alive.

BAININGS PLANTATIONS.

The observational trial with sulphur (applied as gypsum) failed to show any positive results because the whole plantation improved greatly over the twelve months following application. The area had been badly overgrown with Para grass, and it is thought that control of this grass during the year may have been largely responsible for the improvement. Drainage also had been somewhat improved.

BOTANICAL PLOT.

A small plot adjacent to the interplanting trial at Keravat was planted with seed nuts of different types collected from various parts of the Territory. Like the seedlings in the interplanting trial, these suffered severely from *Oryctes* damage, and as a result it was difficult to compare the merits of the various types. However, one of a number of dwarf palm seeds planted in the plot proved to be a natural hybrid. This palm showed very vigorous growth and prolific fruit production, but the nuts were extremely small. In the pure dwarfs, a tendency to periodic bearing was observed—spathes were produced regularly for a few months followed by a non-flowering period. This could be partly a result of *Oryctes* effects, although alternate bearing is a well-recognized phenomenon with many dwarf types.

FREQUENCY OF SPATHE OPENING.

From January, 1961, all new spathes opening in the interplanting trial and botanical plot were tagged at weekly intervals, with the date noted. The interval varied from less than one week up to six weeks. Including only palms on which four or more spathes had opened, the average interval for 128 spathes on 22 trees was 22.3 days. This means that a new spathe would normally have been open at the time the female flowers of the previous spathe were receptive, so that self-pollination could have occurred. However, it is anticipated that as the trees start carrying a crop, the rate of spathe production will slow down and self-pollination will be precluded.

ROBUSTA COFFEE (*Coffea canephora*).

CLONAL SEED PRODUCTION.

During the past year the establishment of polyclonal seed gardens at six centres in the Territory was completed, all gardens being planted according to the design shown in the 1959–60 Annual Report, which allows for each clone to have an equal opportunity of being pollinated by every other clone. The same twelve Besoeki clones were used through all the gardens which are now established at Epo, Bainyaik, Kapogere, Madang, Popondetta, Kerema and Sohano. One such garden is illustrated in Plate 9. It is again pointed out that the parent clones in these gardens are unproven and the seed produced may not have much higher quality than bulk seed. Their main purpose is to fill the gap until Keravat clones are fully tested. The high yielding characteristics of this strain are illustrated in Plate 10.

CLONAL SEED PRODUCTION—BLOCK 303.

The polyclonal seed garden, planted in March, 1958 using the twelve Besoeki clones, is bearing. Polycrossed seed from this garden will be used for progeny testing.

CLONAL SEED GARDENS, VUNAPAU ROAD.

Two additional polyclonal seed gardens have been established along the road leading from the station to Vunapau Plantation. Each garden is of standard design with twelve cuttings of each of twelve clones planted at 10 ft. x 10 ft. spacing. In the first garden, one of the Besoeki clones was used in combination with eleven clones selected from the pre-war coffee in Block 203. The second garden contained five Besoeki clones, together with seven clones from the pre-war coffee.

PROGENY TRIAL—BLOCK 204.

Clearing of Block 204 has started with poisoning of the old cacao and *Leucaena glauca*. Progenies from the twelve clones in the polyclonal garden in Block 303 will be tested, using sixteen-tree plots in a rectangular lattice design with six replicates.

CLONE TESTING—BLOCK 303.

Planting of this trial has been spread over such a long period (two years) that harvesting records commenced at this stage would be almost impossible to interpret. Age variation of cuttings occurs in all plots in all replicates. This trial will be left for a further twelve to eighteen months, then stumped back, and yield recording will commence on the production from new leaders.

TESTS OF COMBINING ABILITY.

The general combining abilities of all clones in the clone testing trial are being tested. Fifty open-pollinated seedlings from each clone were planted in June, 1959, in two lines of 25 seedlings for each parent. From the results of this trial, it will be possible in the future to obtain some comparison between the performance of clones as such and as parents.

SPACING x PRUNING TRIAL—BLOCK 204.

This trial will be established in the coming year on Block 204. Four spacings, 8 ft., 10 ft. and 12-ft. triangle and 12 ft. x 8 ft. hedge will be compared, together with four pruning treatments. There will be five replicates with spacings as the main plot treatments and pruning treatments as sub-plots.

MANILA HEMP (ABACA).

TWO-ACRE PRODUCTION TRIAL—BLOCK 208.

It seems unlikely that there will be major development of manila hemp as a plantation crop, but it may have a future in the hands of indigenous farmers. The object of this trial is to find the number of man-hours required to develop two acres of manila hemp, and the amount of fibre which can be produced, in order to determine the economics of Native production.

A promising clone, KT6, used for the trial had the following characteristics:

- (a) 3.2 per cent. fibre recovery.
- (b) Fibre strength—56.5 Kg./mm.² (outer).
48.7 Kg./mm.² (inner).
- (c) 15-month maturation time.
- (d) Production 33 per cent. above average for clones tested.

Corms were planted at 13 feet square spacing in Block 208, after initial clearing of the cover of kunai (*Imperata* sp.), *Mimosa invisa* and *Pueraria* by station labour. Clearing costs were not included in the trial on the basis that indigenous operators would normally plant this crop in an old food garden so that special clearing would not be required. All other operations will be carried out by two Station labourers experienced in all phases of manila hemp production.

The trial commenced on 27th June, 1961, and planting was completed by 24th July, 1961. Final decisions have not yet been made on a method of fibre extraction which will allow valid interpretation of the results relative to native production methods. It is possible that normal power driven machinery could be used where processing was carried out by New Guinean groups on a co-operative basis.

By 1963, sufficient information should have been gained to indicate whether commercial Native production of manila hemp is economic.

CLONE x SHADE x SPACING TRIAL—BLOCK 403.

The trial was first harvested in September, 1959, and by April, 1961, had been harvested five times. After the next harvest, the results will be analysed statistically and it will be possible to draw firmer conclusions.

The following interim results have been recorded from the first 18 months of harvesting:

- (i) 13 ft. x 13 ft. spacing produced at the rate of 0.8 tons per acre, being 20 per cent. increase over the yield at 8 ft. x 8 ft. spacing.
- (ii) 10 ft. 6 in. x 10 ft. 6 in. spacing produced at the rate of 0.6 tons per acre, being 6 per cent. increase over the yield at 8 ft. x 8 ft. spacing.
- (iii) Plots shaded in the early stages of growth produced 45 per cent. more fibre than unshaded plots.
- (iv) Two clones K7 and K14 have so far given a fibre yield considerably higher than the average for all clones. K14 produced fibre at the rate of 2 tons per acre in 13 ft. x 13 ft. shaded plots, although only $\frac{1}{3}$ ton per acre in 13 ft. x 13 ft. unshaded plots. K7 yielded at the rate of 1.1 tons of fibre per acre in 13 ft. x 13 ft. shaded plots and 0.7 tons per acre in 13 ft. x 13 ft. unshaded plots.

CLONE TESTING—BLOCK 207.

A new clone testing trial was set down in Block 207 in November, 1960, using the same design as for the clone testing trial in Block 302. Six bridging clones were included from the trial in Block 302, and three bridging clones from the Clone x Shade x Spacing Trial. The first harvest of the new trial should be in mid-1962.

CLONE TESTING—BLOCK 302.

The Clone Testing Trial in Block 302 was harvested in December, 1960, and April, 1961. It is too early to be certain of trends, but it can be stated that K2 and K3 have produced 60 per cent. more fibre than the average for all clones in this trial. KT6, used in the 2-acre Production Trial, was the fourth highest yielder. The vigour of the Keravat clones is well illustrated in Plates 11 and 12.

THE POTENTIAL COMMERCIAL VALUE OF A CLONE—BLOCK 302.

The $\frac{1}{4}$ -acre block of KT8 planted in September, 1957, was first harvested twenty months later (April, 1959). It has now been harvested eleven times, yielding a total of 1,086 lb. fibre from 46,931 lb. of pseudostems, and averaging 2.3 per cent. recovery. At this rate, it is yielding at the rate of 1 ton of fibre per acre per annum.

Generally the yield increased for the first 13–15 months after the first harvest, and has since been declining. This can be seen from Table 33.

TABLE 33.—YIELD OF KT8, BLOCK 302.

Harvest No.	Days Since Previous Harvest.	Weight of Pseudostems (lb.).	Weight of Fibre (lb.).	Per cent. Recovery.
1	0	583	9	1.5
2	42	2,358	53	2.3
3	57	4,410	89	2.2
4	73	3,465	61	1.8
5	78	5,690	134	2.4
6	79	7,812	181	2.3
7	84	6,119	179	2.9
8	47	4,569	97	3.1
9	61	4,444	116	2.6
10	96	3,627	79	2.2
11	125	3,854	88	3.3

The reasons for the decline in yield are worth investigating. The variation in recovery is fairly representative of variations experienced in manila hemp harvests at Keravat. Studies are proposed to determine how much of the variation is real and how much is caused by factors such as variation in stripping efficiency. There may also be age or seasonal components in percentage recovery.

BREEDING AND GENETIC INVESTIGATIONS—BLOCKS 302 AND 207.

The initial crossing programme was completed by the early part of 1961 and no further handcrosses will be produced until the material on hand has been evaluated and an indication obtained of the lines which can be followed to greatest advantage. There are 42 handcrosses in the observation plots, ten of which were planted in July, 1961, and 32 in June, 1960.

A significant achievement was the introduction of six seedlings of Bongulanon variety from North Borneo in April, 1961. These will be multiplied, tested and used in future breeding programmes.

POLYCLONAL SEED GARDEN.

Seed is now being collected and stored in preparation for sub-sampling and testing.

FOOD CROP AGRONOMY.

SOIL EXHAUSTION TRIAL—BLOCK 608.

ELEVENTH PLANTING.

After the tenth planting of the Soil Exhaustion Trial, it was considered that the soil was virtually exhausted, as yields of sweet potato had dropped to $1\frac{1}{2}$ tons per acre. In the eleventh planting, a fertilizer trial was superimposed, using four levels of phosphorus and nitrogen in all combinations, the levels ranging from no N and no P to 200 lb. per acre of N and 400 lb. per acre of P. Each of the sixteen plots was quartered and four replications of the



Plate 11—*Manila hemp* is vigorous and productive at Keraul.

[Photo : D.I.E.S.]



Plate 12—Harvesting mature pseudostems of *Manila hemp*.

[Photo : D.I.E.S.]

fertilizer combinations applied. Zinc and iron were also applied at suitable rates, singly, in combination, and as nil treatments. An application of a complete mixture of minor elements was confounded with the blocks. All fertilizer mixtures were applied at planting.

Top growth responses to nitrogen application were spectacular, and varied with rate of application. Phosphate responses were less spectacular, but even the lowest phosphate treatment showed top growth improvement over nil phosphate.

After the first ten weeks, leaf samples were taken for analysis at monthly intervals. Results showed that leaf nitrogen content originally depended on the rate of soil application, with values declining rapidly and tending towards a common value of about 3 per cent., one month before harvest. The sample taken just prior to harvest showed a rise to about 3.8 per cent. in all plots. This effect will be checked to determine whether it was real.

In spite of the fertilizer applications, the yield from all plots averaged only $1\frac{1}{2}$ tons per acre. Results have not yet been analysed statistically, but no response to phosphate, iron, zinc, or minor element applications was evident. Plot yields were inversely proportional to rates of nitrogen application. Nil nitrogen treatments averaged two tons per acre, while plots receiving 200 lb. per acre of N averaged only $1\frac{1}{2}$ tons per acre, with the two intermediate application rates producing intermediate yields.

It was considered that these results may have been caused by rapid nitrogen losses through leaching. The trial was therefore repeated, using three split applications each at one third of the original fertilizer rates on appropriate plots.

TWELFTH PLANTING.

Three fertilizer applications were made as side dressings when the crop was aged one month, three months and five months, the last dressing being applied two months prior to harvesting. Monthly leaf analyses showed leaf nitrogen content directly proportional to nitrogen application. Nil nitrogen treatments showed a general steady downward trend to 3.4 per cent just prior to harvesting, while the other treatments showed a marked rise and fall in content in accordance with the time of fertilizer application. The levels of phosphorus were also in accordance with rates of application, remained fairly constant throughout, but fell markedly just prior to the harvest.

Top growth responses were just as spectacular as in the eleventh planting, but in this case retained their differential appearance throughout the cropping period. From a visual inspection just prior to harvesting, points were allotted to each plot as follows:

- 2 Good growth
- 1 Fair growth
- 0 Poor growth.

Total scores are shown in Table 34.

TABLE 34.—TOP GROWTH RESPONSES OF SWEET POTATO TO NITROGEN AND PHOSPHORUS.

N_0	2	P_0	17
N_1	14	P_1	18
N_2	23	P_2	16
N_4	31	P_4	19

These scores were in close agreement with similar observations made ten weeks after the trial commenced.

From these observations and leaf analysis data, it can be postulated that nitrogen availability was sufficient to maintain production at a reasonable level. However, the yield pattern was almost identical with that from the eleventh planting, although yields averaged $2\frac{1}{2}$ tons per acre. Results have not been analysed statistically, but once again the indications are that there was no response to phosphorus, iron, zinc, or minor elements. The lack of response to phosphorus, applied in the form of superphosphate, is an indication that a sulphur deficiency is not likely. Response to nitrogen was inversely proportional to the rate of application, nil treatments yielding at the rate of $3\frac{1}{2}$ tons per acre and 200 lb. N per acre treatments yielding at the rate of 2 tons per acre.

Soil samples from all 64 plots have been collected for chemical analysis.

From the results of the eleventh and twelfth plantings, it was assumed that some other element or elements were limiting yield responses to fertilizer applications.

THIRTEENTH PLANTING.

This is the current planting and is being used to eliminate residual fertilizer responses from the plots, prior to application of a new fertilizer trial. To gain some indication of the most suitable fertilizer treatments for this trial, two pot trials are being carried out. Equal volumes of soil from all plots were collected at the conclusion of the twelfth planting and thoroughly mixed for use in the trials.

N K TRIAL.

Four levels of nitrogen, ranging from nil to 800 lb. per acre of N, and four levels of potash, ranging from nil to 2 cwt. muriate of potash per acre, were mixed in all combinations in sixteen pots. Sorghum was the test plant, four plants per pot. The trial has not yet been harvested, but observations suggest a positive response to nitrogen at 200 lb. per acre, and a negative response to higher rates. Muriate of potash at $\frac{1}{2}$ cwt. per acre and 1 cwt. per acre appears to be giving positive responses while at 2 cwt. per acre a decline in vigour is apparent.

OMISSION OF NUTRIENTS TRIAL.

A trial using twelve treatments with six replications has been commenced to study the full nutrient status of the soil by the omission method. The treatments are:

1. Control
2. Control
3. Complete nutrients
4. Complete nutrients
5. Complete nutrients—nitrogen
6. Complete nutrients—phosphorus
7. Complete nutrients—potassium
8. Complete nutrients—calcium
9. Complete nutrients—magnesium
10. Complete nutrients—minor elements
11. Complete nutrients—sulphur
12. Complete nutrients—sulphur.

The trial has not yet been harvested, but observations of growth suggest that complete and complete minus sulphur treatments are inseparable and superior to all other treatments.

THREE COURSE ROTATION TRIAL.

The second cycle of the rotation trial has been completed, and it has been decided to continue the trial for another cycle to gain further information.

Results, conclusions and recommendations from the first two cycles will be published at a later date. The figures have not yet been analysed, but certain trends are clear.

The trial is designed so that at every second planting, one complete series is under sweet potato (the indicator crop). At every other planting, the three narrow rotation treatments of one of the three series are under sweet potato. By comparing the yields of sweet potato in each successive planting of the first cycle of the rotation with the corresponding yields in the second cycle, comparisons can be made between yields of the same plots after they have supported one complete cycle of the rotation. These yields are shown in Table 35 as tons per acre of sweet potato.

TABLE 35.—SWEET POTATO YIELDS IN 3-COURSE ROTATION TRIAL.

Rotation.			1st Cycle.						2nd Cycle.					
			Planting.						Planting.					
			1.	2.	3.	4.*	5.	6.	1.	2.	3.	4.	5.	6.
R ₁	..	..	8	..	11	..	7 $\frac{3}{4}$	..	5 $\frac{3}{4}$	..	7 $\frac{1}{2}$	..	5	..
R ₂	..	..	8 $\frac{1}{2}$	..	11	..	7 $\frac{1}{2}$	..	6	..	6 $\frac{3}{4}$	..	6 $\frac{1}{2}$	..
R ₃	..	..	8 $\frac{1}{2}$	2 $\frac{1}{2}$	11 $\frac{1}{2}$	..	7	5	6 $\frac{1}{2}$	5 $\frac{1}{2}$	6	2 $\frac{1}{2}$	6 $\frac{1}{2}$	3
R ₄	..	..	10 $\frac{1}{2}$	3	11	..	6	7	7	6	4 $\frac{1}{4}$	3 $\frac{1}{4}$	3 $\frac{1}{2}$	2
R ₅	..	..	9	3 $\frac{1}{2}$	9 $\frac{1}{2}$	..	7 $\frac{1}{2}$	6 $\frac{1}{4}$	6 $\frac{1}{2}$	6 $\frac{1}{2}$	4 $\frac{1}{2}$	3	4 $\frac{1}{2}$	2
R ₆	..	..	8 $\frac{1}{2}$	..	12 $\frac{1}{2}$	..	6 $\frac{1}{2}$	..	7	..	9	..	7	..
R ₇	..	..	8 $\frac{1}{2}$	..	14	..	6 $\frac{1}{2}$	..	6 $\frac{3}{4}$	..	9	..	7 $\frac{3}{4}$	..

* Yields not recorded in 4th Planting, 1st Cycle, as crop wiped out by disease.

Yields from the wide rotations R1, R2, R6 and R7 are also shown in Table 36 in comparison with yields from the narrow rotations R3, R4 and R5.

TABLE 36.—SWEET POTATO YIELDS IN WIDE AND NARROW ROTATIONS.

Planting.					Rotation.	1st Cycle.	2nd Cycle.
						Yield (tons per acre).	Yield (tons per acre).
1	..	..	..	..	Wide	8½	6½
					Narrow	13½	6½
2	..	..	..	..	Narrow	3	6
					Wide	12	8
3	..	..	..	..	Narrow	10½	5
					Wide	7	3½
4	..	..	..	..	Narrow	7	6½
					Wide	7	4½
5	..	..	..	..	Narrow	6	2½
					Wide	7½	5½
6	..	..	..	..	Average	7½	5½

In the first cycle, wide rotations averaged 9½ tons/acre, and narrow averaged 6½ tons/acre. In the second cycle, these averages had dropped to 7 tons/acre and 4½ tons/acre respectively. Similarly, taro yields have dropped from the first to the second cycle from 1.7 tons/acre in the wide rotations, and 1.5 tons/acre in the narrow rotations, to 1.0 and 1.2 tons/acre respectively, in spite of the fact that two narrow and one wide rotation planting in the first cycle were destroyed by disease.

The comparison between the peanut yields of the first and second cycle is unsatisfactory owing to a change to the higher yielding variety Schwartz 21 for the second cycle. This was necessitated by severe attack on the crop by *Sclerotium rolfsii* throughout the first cycle. This attack was severe enough to wipe out the second and third plantings. However, a comparison of rotations shows that wide rotations averaged at the rate of 19 cwt. per plot, as against 12 cwt. for the narrow rotations.

An example of the yield trends in all rotations within a series is shown in Table 37. Yield figures for the seven rotations in Series A over two complete cycles are given as tons per acre, averaged over three replicates.

TABLE 37.—YIELD TRENDS IN ROTATIONS IN SERIES A, 1ST AND 2ND CYCLES.

Planting.					Rotation.						
					1.	2.	3.	4.	5.	6.	7.
1st Cycle	1..	..	SP-8	SP-8½	SP-8½	SP-10½	SP-9	SP-8½	SP-8½	SP-8½	SP-8½
	2..	..	To-2½	So-0.7	To-2	To-1½	To-2	To-2	To-2	To-2	So-0.7
	3..	..	P-0	P-0	Ph	P-0	P-0	P-0	P-0	P-0	P-0
	4..	..	M	M	SP-0	SP-0	SP-0	Pu	Pu	Pu	Pu
	5..	..	M	M	To-2½	To-2½	To-2½	Pu	Pu	Pu	Pu
	6..	..	M	M	Ph	P-0.4	P-0.4	Pu	Pu	Pu	Pu
2nd Cycle	1..	..	SP-5½	SP-6	SP-6½	SP-7	SP-6½	SP-7	SP-6½	SP-6½	SP-6½
	2..	..	To-1½	So-0.5	To-1	To-1½	To-1½	To-1½	To-1½	To-1½	So-0.6
	3..	..	P-1.2	P-1.6	Ph	P-1.2	P-1.3	P-1.3	P-1.3	P-1.3	P-1.2
	4..	..	M	M	SP-2½	SP-3½	SP-3	Pu	Pu	Pu	Pu
	5..	..	M	M	To-1	To-1½	To-1½	Pu	Pu	Pu	Pu
	6..	..	M	M	Ph	P-1.0	P-0.8	Pu	Pu	Pu	Pu

SP = Sweet potato. To = Taro (*Colocasia*). So = Sorghum. P = Peanuts. M = Mimosa.
Pu = Pueraria. Ph = *Phaseolus calcaratus*.

Again it may be seen that the decline in sweet potato yields in the narrow rotations R3, R4 and R5 has been rapid and obvious, whereas in the wider rotations, although yields have fallen, the total effect is not so apparent. In the above series, the sweet potato crop harvested from the first planting of the third cycle will be the best indicator. However, the crop production figures in general indicate that although the wide rotations were superior to the

narrow rotations, they were not adequate to maintain stable production. It has also been pointed out in previous reports that in such a rotation there is a serious build-up in insect pests and diseases, due in the main to the presence of a continuous reservoir of host plants. The weed problem is also likely to become acute in subsistence gardens although this has been obviated in this trial by constant hand weeding. Therefore, as an attempt to find a means of maintaining stable foodcrop production by rotational cropping, this trial has fallen short of the mark but at the same time has given some extremely valuable information.

PROPOSED NEW ROTATION TRIAL.

Consideration of the results from the above trial together with those reported from many overseas trials (see "Shifting Cultivation and Crop Rotations in the Tropics"—K. Newton. *Papua and New Guinea agric. J.* **13**, (3): 81–118 (1960).), has led to the following assessment of the problems associated with food crop production in lowland rainforest areas similar to the area in which Keravat is located.

(i) In tropical rainforest and other high rainfall regions where ample land is available for cultivation, the bush fallow rotation will maintain fertility as effectively as any other system of agriculture. Any trials which are conducted should be designed to investigate:

- (a) The possibility of replacing or combining with the bush fallow a planted tree fallow using either indigenous forest species or vigorously-growing leguminous trees such as *Gliricidia* and *Leucaena* species. These should be carefully investigated for the occurrence and effectiveness of nodulation. When clearing for cultivation, trees may be either lopped and crops grown between rows or stumped and crops grown over the whole area.
- (b) Modification of the bush fallow to a system such as the "Corridor" system of the Congo, which will lead to stabilization of the community with its attendant benefits and probably greater and more economic production of food.
- (c) Comparison between bush fallow and a perennial creeping legume fallow with appropriate consideration of the vigour, depth of rooting and nodulation of the legume used.

(ii) In tropical rainforest and other high rainfall areas where population density is high and a land shortage exists, one of the first lines of approach should be an investigation into the availability of inorganic fertilizers, existing mineral deficiencies, the economics of fertilizer application and the problems presented in persuading the peasant farmer to use fertilizers. Crop yield and net farm incomes in the Congo have been increased considerably through the use of commercial fertilizers and by ploughing in a cover crop such as velvet bean (*Mucuna*) or *Crotalaria*.

A further line of approach and one which has shown promise in the Congo is the incorporation of cattle into the farming system and the establishment of a rotation based on alternate cropping with subsistence foods and grazing on grass or grass legume leys.

The problems associated with the establishment of a trial to investigate the above factors are currently under consideration and it is hoped that within the next 12 months this trial will be started. Treatments which may be used include comparisons between four- and six-year fallow periods under natural bush, planted trees, legume trees, and shrubs and grasses grazed and ungrazed, with variations of perhaps one, two and three years for the cropping period.

SWEET POTATO MATURITY TRIAL.

In the 1959–60 Annual Report, it was mentioned that soil deterioration was causing earlier maturity of sweet potato according to the method used for determination of maturity. However, there is some doubt as to what criteria should be used for this determination and in an attempt to solve the problem, a Sweet Potato Maturity trial has been superimposed on the current Series A of the Three Course Rotation Trial, which is all under sweet potato. There are 21 plots in the series. One row of each of the ten rows per plot is being harvested every week. Observations are being made on yield, number of tubers, condition of vine, number of flowers per row at harvesting, fluidity of exudate from a cut tuber, and the colour of this exudate after drying.

At the conclusion of this trial, a clearer understanding of sweet potato maturity may be obtained.

HIGHLANDS AGRICULTURAL EXPERIMENT STATION, AIYURA.

COFFEE (*Coffea arabica*).

Many of the coffee trials at Aiyura have been affected by a defoliation and die-back condition which has appeared in patches in most of the blocks on pit-pit soil. The nature of the condition is uncertain but it may be related to soil water relationships or nutrient status. Frequently perfectly healthy bushes occur next to defoliated and dying bushes. It is also notable that the affected bushes had grown perfectly normally in the early stages. An early symptom was the development of black necrotic margins on the leaves. This has been considered to be caused by potassium deficiency. Early results with potash fertilizers suggest that deficiency of this element is not the whole cause of the syndrome. The results of some trials are seriously affected by this condition.

COFFEE BREEDING.

PROGENY TESTING—BLOCK E6.

The progenies derived from self and open pollinated seed are just beginning to bear in the first and second series. It will be some years before there is sufficient information to enable differences between progenies to show up clearly.

COFFEE INTRODUCTIONS—BLOCKS A6, E5, D5.

The first harvest has now been taken from these introductions but it will be some time before any deductions may be made.

COFFEE AGRONOMY.

SHADE SPECIES x SPACING x PRUNING TRIAL—BLOCKS C6, D6, B15-16.

The four shade species used in this trial, which covers 20 acres, are *Albizia stipulata*, *Casuarina* sp., *Grevillea robusta* (Silky Oak), and no shade. The coffee variety is Blue Mountain and the spacings are 7 ft. x 7 ft., 8 ft. x 8 ft., and 9 ft. x 9 ft. on the triangle. Each plot is split into two pruning systems, namely single and multiple stem.

To date the no shade plots are outyielding all the shades, with *Grevillea* shade in second place, primarily because the *Grevillea* has made poor growth so that its plots approximate to the no shade plots. Yields are also directly proportional to the number of trees per acre at this early stage, i.e., 7 ft. x 7 ft. spacing is highest and 9 ft. x 9 ft. lowest.

Multiple stem pruning has so far outyielded single stem in Blocks C6 and D6 whilst in Blocks B15-16 the position is reversed. The reason for the reversal is probably the fact that the pruning in Block B15-16 was relatively heavy. In all blocks the multiple stem trees were pruned up by removing ten pairs of laterals, which was much more severe on Block B15-16 where the coffee bushes were not so well grown than on the well-grown bushes in C6 and D6.

The yields to date are summarized in Table 38.

Factors for conversion of cherry to dry coffee have been worked out from time to time for the different treatments. They are summarized in Table 39. Examination of Table 39 shows that there is a tendency for a higher recovery from unshaded plots, especially in Block B15-16, but the recovery of dry coffee irrespective of treatment is consistently higher from Blocks C6 and D6 than from Block B15-16.

VARIETY x SPACING TRIAL—BLOCK B5.

This trial incorporates two spacings, namely 9 ft. x 9 ft. and 7 ft. 6 in. x 7 ft. 6 in. on the triangle. The five varieties are Blue Mountain, Arusha, Mocha, San Ramon, and Bourbon. As mentioned in the previous report, Bourbon is at a disadvantage, having been planted nine months later than the other varieties.

The results for the second year of substantial yield are interesting and varietal differences are beginning to emerge. Mocha, Arusha, and Bourbon are now outyielding Blue Mountain and San Ramon. Bourbon is behind Mocha, Arusha and Blue Mountain over the three-year period, but, if its initial disadvantage is taken into account, it is now yielding as well as any other variety. Period and cumulative yields are shown in Table 40.

TABLE 38.—SHADE, SPACING, PRUNING TRIAL—AIYURA.

YIELDS (LB. OF CHERRY), MAY, 1958–MARCH, 1961.

Shade.	Spacing.	May, 1958–March, 1959.			April, 1959–March, 1960.			April, 1960–March, 1961.			Grand Total.
		Single.	Multiple.	Total.	Single.	Multiple.	Total.	Single.	Multiple.	Total.	
<i>Casuarina</i> sp.	7 x 7	611	67	678	3,724	3,288	7,012	4,754	4,930	9,684	17,374
	8 x 8	476	50	526	3,201	3,267	6,468	3,936	3,574	7,510	14,504
	9 x 9	485	48	533	2,947	2,297	5,244	3,344	3,254	6,598	12,375
<i>Albizia stipulata</i>	7 x 7	654	36	690	4,132	3,754	7,886	4,503	6,044	10,547	19,123
	8 x 8	498	23	521	3,387	2,449	5,836	3,661	3,190	6,851	13,208
	9 x 9	480	32	512	2,940	2,474	5,414	3,221	3,385	6,606	12,532
<i>Grevillea robusta</i>	7 x 7	569	34	603	4,479	4,191	8,670	5,604	5,922	11,526	20,799
	8 x 8	467	34	501	3,595	3,430	7,025	4,178	4,687	8,865	16,391
	9 x 9	419	24	443	2,901	2,289	5,190	3,868	3,241	7,109	12,742
No shade ..	7 x 7	491	27	518	4,537	4,547	9,084	6,082	6,156	12,238	21,840
	8 x 8	424	21	445	3,846	3,600	7,446	4,315	4,850	9,165	17,056
	9 x 9	268	4	272	2,834	3,105	5,939	3,954	4,050	8,004	14,215
Total	..	5,842	400	..	42,523	38,691	..	51,420	53,283	..	192,159

Spacings—

7 x 7	..	..	79,136
8 x 8	..	..	61,159
9 x 9	..	..	51,864

Shade—

Casuarina	..	44,253
Albizia	..	44,863
Grevillea	..	49,932
No shade	..	53,111

TABLE 39.—SHADE, SPACING, PRUNING TRIAL—AIYURA.

OVEN-DRY WEIGHT OF HULLED COFFEE AS PERCENTAGE OF CHERRY WEIGHT.

Field.		C6.		D6.		Average C6, D6.		Average B15–16.	
Pruning.		Multiple Stem.	Single Stem.	Multiple Stem.	Single Stem.	Multiple Stem.	Single Stem.	Multiple Stem.	Single Stem.
Shade— <i>Casuarina</i> sp.	Spacing— .. 7 x 7 ..	14.2	14.3	15.8	14.2	14.9	14.2	12.5	12.9
	8 x 8 ..	13.8	13.5	15.1	13.2	14.4	13.3	12.0	11.9
	9 x 9 ..	14.0	13.4	14.7	13.9	14.3	13.8	12.3	12.2
<i>Albizia stipulata</i> ..	7 x 7 ..	14.1	13.9	15.7	14.5	14.8	14.2	12.0	12.9
	8 x 8 ..	15.0	14.0	15.6	15.3	15.3	14.8	12.5	12.2
	9 x 9 ..	13.8	14.8	14.2	14.3	14.0	14.5	12.5	12.2
<i>Grevillea robusta</i> ..	7 x 7 ..	15.5	14.3	14.8	13.7	15.1	14.0	12.8	12.5
	8 x 8 ..	14.9	14.0	14.5	13.3	14.7	13.6	12.6	12.3
	9 x 9 ..	14.8	14.4	14.3	13.3	14.5	13.8	13.3	12.9
No shade ..	7 x 7 ..	14.8	14.2	14.6	13.6	14.7	13.9	13.7	13.1
	8 x 8 ..	14.7	14.5	14.6	14.5	14.6	14.5	13.2	13.3
	9 x 9 ..	14.8	14.1	14.8	14.9	14.8	14.4	13.1	13.4

It is noticeable that, as in the other spacing trial with Blue Mountain, closer spacing has a distinct yield advantage in the early years.

Factors for conversion of cherry weight to dry coffee show appreciable differences between varieties. Blue Mountain has given the highest recovery, with Arusha falling well behind the other varieties. When the plot yields are corrected by the conversion factor, Arusha does not show up as well as Mocha and Bourbon. Table 41 summarizes the results.

It is unfortunate that Block B5 is one of the areas most affected by the die-back condition mentioned previously. This may interfere seriously with results in the future.

TABLE 40.—VARIETY x SPACING TRIAL, B5—AIYURA.
GRAND TOTAL—MAY, 1958, TO MARCH, 1961 (LB. CHERRY COFFEE).

Variety	May, 1958, to March, 1959.			April, 1959, to March, 1960.			April, 1960, to March, 1961.			Variety Total.
	9 ft. x 9 ft.	7 ft. 6 in. x 7 ft. 6 in.	Total.	9 ft. x 9 ft.	7 ft. 6 in. x 7 ft. 6 in.	Total.	9 ft. x 9 ft.	7 ft. 6 in. x 7 ft. 6 in.	Total.	
Blue Mountain	131	255	386	756	1,516	2,272	836	1,224	2,060	4,718
Arusha ..	159	186	345	1,408	1,482	2,890	1,289	1,760	3,049	6,284
Mocha ..	149	217	366	1,797	1,930	3,727	1,285	1,785	3,070	7,163
San Ramon ..	99	168	267	509	874	1,383	868	1,228	1,996	3,646
Bourbon ..	..	..	..	379	574	953	984	2,034	3,018	3,971
	538	826	4,849	4,849	6,376		5,262	7,931		

Total for spacings 9 ft. x 9 ft. 10,649

7 ft. 6 in. x 7 ft. 6 in. 15,133.

Figures shown are 4-plot totals—

i.e., for 9 ft. x 9 ft. 84 trees

for 7 ft. 6 in. x 7 ft. 6 in. 144 trees.

TABLE 41.—VARIETY x SPACING TRIAL, B5—AIYURA.
6TH JUNE, 1961.—OVEN-DRY WEIGHT HULLED COFFEE AS A PERCENTAGE OF CHERRY WEIGHT.

Spacing	9 ft. x 9 ft.				7 ft. 6 in. x 7 ft. 6 in.				Total 9 ft. x 9 ft.	Total 7 ft. 6 in. x 7 ft. 6 in.
	Blocks.				Blocks.					
	I.	II.	III.	IV.	I.	II.	III.	IV.		
Variety.										
Blue Mountain ..	14.2	14.2	13.8	14.2	14.5	15.0	14.7	14.2	56.4	58.4
Arusha ..	11.7	10.6	11.2	11.8	11.1	12.0	10.8	12.1	45.3	46.0
Mocha ..	13.8	13.6	12.9	13.2	13.2	13.1	13.7	12.2	53.5	52.2
San Ramon ..	12.6	12.0	11.4	13.0	12.7	12.8	13.1	13.2	49.0	51.8
Bourbon ..	12.7	13.2	12.2	12.3	12.9	12.5	12.5	12.7	50.4	50.6
	65.0	63.6	61.5	64.5	64.4	65.4	64.8	64.4	254.6	259.0
Spacing 9 ft. x 9 ft.				..	65.0	63.6	61.5	64.5		
Block Total					129.4	129.0	126.3	128.9		

CULTURAL METHODS x SPACING TRIAL—BLOCK C3.

This trial includes two spacings, namely 9 ft. x 9 ft. on the triangle and 14 ft. x 5 ft. in avenues, the latter spacing being designed to permit mechanical cultivation. The treatments are clean weeding, weeds slashed, mulching and two ground covers, namely *Indigofera endecaphylla* and *Vigna oligosperma*. The soil is a shallow stiff clay loam with poor drainage.

The trial has now been concluded and has shown that on this soil type mulching gives the greatest yield, with clean weeding second, weeds slashed third, and ground covers falling a long way behind the other treatments, particularly the vigorous *Indigofera endecaphylla*. The growth of *Vigna* was relatively poor and it was not an effective cover on some plots. It has also emerged that avenue planting is inferior to standard triangular planting with the same number of trees per acre.

An interesting finding was that labour usage on the clean weeded plots was lower than with any other treatment. In the mulched plots the elephant grass used for mulch frequently rooted at the nodes and it was necessary to go over the plots fairly frequently to pull out the plants resulting therefrom. In the slashed plots hard grasses quickly began to dominate the soft weeds and it was also necessary to pull them out by hand to prevent degeneration of these areas. Even in the cover cropped plots the labour required to weed the covers and

to cut them back periodically was about as great as that required for clean weeding. It is thus evident that the two highest yielding treatments, namely mulching and clean weeding, were the most desirable from all viewpoints.

The results for this trial are summarized in Table 42. They are being written up fully for publication in the *Papua and New Guinea Agricultural Journal*.

TABLE 42.—SPACING X CULTIVATION X COVER CROP TRIAL—AIYURA.

GRAND TOTAL YIELD, JUNE, 1958–MARCH, 1961.

Treatment.	Cherry Weight (in lb.).			
	June, 1958– March, 1959.	April, 1959– March, 1960.	April, 1960– March, 1961.	Total. ¹
<i>Spacing 9 ft. x 9 ft.</i>				
Clean Weeded	357	2,664	3,543	6,564
Mulch	595	2,976	4,626	8,197
Vigna	211	1,328	2,903	4,442
Indigofera	112	1,169	1,052	2,333
	1,275	8,137	12,124	21,536
<i>Spacing 14 ft. x 5 ft.</i>				
Vigna	278	1,538	2,246	4,062
Indigofera	272	1,251	1,620	3,143
Clean Weeded	372	2,190	2,936	5,498
Weeds Slashed	355	1,795	2,013	4,163
	1,277	6,774	8,815	16,866

¹ Annual totals are for 4 plots — 224 trees.

VARIETY X SPACING X PRUNING TRIAL—BLOCK B14.

The details of this trial were given in the 1959–60 Annual Report. The first harvests have now been made and the relative performances of the varieties were much the same as last year.

PRUNING TRIAL—BLOCK A10.

Results in this trial, which compares no pruning and light pruning with heavy pruning, were much the same as in the previous year, with light or no pruning continuing to yield more than heavy pruning.

The amount of variation between replicates is causing some concern and the possibility is being examined of using the circumference of the main stem of each bush as a covariate in order to increase precision.

FERTILIZER TRIALS—BLOCKS B15–16 AND E7.

The diagnostic fertilizer trials yielded little additional data but indicated the need to examine the sulphur requirements of coffee on these soils more closely.

The omission method trials likewise were rather unproductive and nothing emerged except a possible slight depression in the minus nitrogen and minus molybdenum plots. Field examination of these plots suggested that the nitrogen effect might be real but the molybdenum effect could be accounted for by the fact that several replicates suffered from local poor drainage. The results are summarized in Table 43.



Plate 13—A coffee bush is bent over to encourage the production of upright shoots for the Agobiada system of multiple-stem pruning.

[Photo : D.I.E.S.]



Plate 14—One upright is removed annually to renew the cycle on coffee pruned to the Agobiada system.

[Photo : D.I.E.S.]

TABLE 43.—OMISSION METHOD FERTILIZER TRIAL, E7, AIYURA.
CUMULATIVE YIELD, JANUARY, 1959, TO MARCH, 1961 (LB. RIPE CHERRY).

Treatment.	January, March, 1959.	April, 1959– March, 1960.	April, 1960– March, 1961.	Total.
1. Complete	40.6	166.9	326.1	533.6
2. Less calcium sulphate	45.5	175.0	311.2	531.7
3. Less calcium hydroxide	52.1	170.9	272.7	495.7
4. Complete plus calcium hydroxide	70.9	219.6	312.2	602.7
5. Less phosphorus	58.3	228.0	387.8	674.1
6. Less nitrogen	33.4	137.9	300.6	471.9
7. Less potassium	63.5	151.8	316.4	531.7
8. Less magnesium	42.3	165.7	337.7	545.7
9. Less copper	63.7	164.4	411.8	639.9
10. Less zinc	67.5	185.1	359.9	612.5
11. Less molybdenum	33.4	118.9	289.4	441.7
12. Less iron	60.2	200.4	383.5	644.1
13. Less manganese	59.2	174.3	311.2	544.7
14. Complete	48.1	179.0	308.1	535.2
Total	738.7	2,437.9	4,628.6	7,805.2

Spacing: 9 ft. x 9 ft. triangle = 621 trees per acre.

Annual totals are for 6 replicates of 6 tree plots, i.e., 36 trees.

HIGH LEVEL FERTILIZER TRIAL—BLOCK E7.

As in the previous year all fertilizer plots were better than the controls and there was a tendency for K2 to be better than K1. The suggestion that potassium might be a limiting factor in production was also borne out by leaf analyses.

The nutrients supplied to this trial were as follows:—

N1	..	..	3 cwt. per acre of Sulphate of Ammonia
N2	..	..	9 cwt. per acre of Sulphate of Ammonia.
P1	..	..	2 cwt. per acre of Superphosphate.
P2	..	..	6 cwt. per acre of Superphosphate.
K1	..	..	1 cwt. per acre of Muriate of Potash.
K2	..	..	3 cwt. per acre of Muriate of Potash.
Minors	..	..	Approximately 100 lb. per acre of complete minor elements.

The results to date are tabulated in Table 44.

TABLE 44.—HIGH LEVEL FERTILIZER TRIAL WITH SHADE.
YIELDS (LB. CHERRY), NOVEMBER, 1958, TO APRIL, 1961.

Treatment.	Grassland. Yield A.	Pit Pit. Yield B.	Total.
1. N1 P1 K1 + Minors	599	529	1,128
2. N1 P1 K2 + Minors	644	660	1,304
3. N2 P1 K1 + Minors	735	584	1,319
4. N2 P1 K2 + Minors	701	612	1,313
5. N1 P2 K1 + Minors	603	467	1,070
6. N1 P2 K2 + Minors	761	507	1,268
7. N2 P2 K1 + Minors	445	609	1,054
8. N2 P2 K2 + Minors	636	542	1,178
9. N2 P2 K2 — Minors	675	507	1,182
10. N2 P2 K2 — Minors	644	567	1,211
11. No Fertilizer	428	482	910
12. No Fertilizer	437	450	887
	7,308	6,516	13,824

MINOR TRIALS AT OUTSTATIONS.

The results of the minor trials at outstations generally followed the same pattern as those obtained at Aiyura with the reservation that in the drier environment at Goroka unshaded plots were inferior to shaded plots in all trials.

PYRETHRUM.

There has been further progress in the establishment of clonal seed gardens consisting of two or more clones of tested pyrethrins content. Table 45 indicates what new gardens were established this year.

TABLE 45.—PYRETHRUM CLONAL SEED GARDENS.

Clones.							Block.	No. of Splits Planted.
2 x 15	..	..	..	..	..	..	A3	755
78 x 82	..	..	..	..	..	..	B17	2,516
78 x 84	..	..	..	..	..	..	A7	1,022
76 x 66	..	..	..	..	..	..	C4	1,087
65/59 x 50	..	..	..	..	..	..	D7	1,904
51 x 64	..	..	..	..	..	..	F7	1,134
78 x 82 x 84 x 93	..	..	..	..	..	..	Chiraben	3,823
70 x 82	..	..	..	..	..	..	B3	1,395
70 x 82	..	..	..	..	..	..	C7	2,600

SOIL EXHAUSTION AND ROTATION EXPERIMENTS.

The ninth planting of the soil exhaustion trial has now been made. Yields of sweet potato are still holding up well.

The crop rotation experiment is entering the third planting of the second cycle. Yields are also being well maintained in this trial and clear trends are not yet evident.

MANAGEMENT TRIAL—SWEET POTATO.

The commonest method of management of sweet potato gardens in the highlands is to remove tubers carefully as they mature and then pack the soil in again without disturbing the vine. This practice may continue for at least eighteen months without the necessity to replant the crop. A trial has been laid down to determine whether regular complete harvesting and replanting gives better results than the usual village management practice.

PASTURES.

Two interesting pasture species introduced and planted in row plots were NG 4854, *Eragrostis curvula*, and NG 4851, *Phalaris stenoptera*. Both species made excellent growth and had a desirable habit. They will be tried in larger plots for productivity and grazing value.

TOBACCO.

With the development of tobacco growing for twist production in the highlands, Aiyura has undertaken the production of pure seed. Two Kentucky types, Ky151 and Ky160, and one bright leaf type, Improved Yellow Mammoth, are being maintained and multiplied in isolated seed gardens. Some selection is going on within the seed gardens in an attempt to improve leaf weight.

FISH.

The *Tilapia* in the pond were destroyed, as experience has shown that this species has an unsatisfactory growth rate at highland elevations. Golden Carp were then introduced from the Dobel ponds at Mount Hagen. Eight carp received on 3rd February with an average length of 6 inches measured 9 inches by 7th March. One of these fish which was killed by a crane on the 26th April then measured 13 inches and weighed 2 lb. 5½ oz. Similar rapid growth rates were recorded with a further 23 fingerlings received on the 21st April.

AGRICULTURAL EXPERIMENT STATION, EPO.

Seasonal conditions at Epo in 1960-61 were particularly unfavourable. There was a late start to the wet season followed by prolonged dry periods during its main course. Of 145 acres of bulk and seed increase rice only 90 acres was worth harvesting and the average yield was only 300 lb. per acre.

RICE BREEDING AND AGRONOMY.

INDICA-JAPONICA HYBRIDS.

Further selection was carried out in the group of *Indica-japonica* hybrids and ten individual selections retained for further field testing.

INTRODUCTIONS FROM THE PHILIPPINES.

Four of the Philippine varieties, namely NG 4062, Elonselom; NG 4064, Vincer; NG 4066, Fa Yin Tsai; and NG 4068, Wong Hok Chai Mei, were retained for field trial.

PURE LINE SEED PRODUCTION.

During 1960 six head selections were made from each of the following varieties:

Toentoeng	Madang
Mekeo White	E 1
Anbar Bau	K 1
Magnolia	52/16.0.2
Canoni	TP 1252
Gopher Short	TP 382
Blue Bonnet	

Each was planted in head rows (each head sown in a separate row) in January. Subsequently from these six rows, three were chosen for uniformity, and from these rows, five head selections were made, totalling fifteen selections comprising three families of five selections.

Of the thirteen varieties under consideration, Canoni was found to be identical with Madang and as a result was discarded. Canoni is no longer maintained. It would appear that the variety grown under the name Canoni for the past few years has in fact been predominantly Madang.

The variety Blue Bonnet was not uniform. Five types have been isolated and these will again undergo head row testing and selection next year.

For the remainder, the fifteen selections will be sown in head rows grouped into three families each of five selections. One family will be chosen for complete uniformity. From the selected family, three of the best rows will be selected, from which five selections will be made, and the above processes will be repeated in order to maintain continuity of the programme. The remainder of the selected family will be bulked and sown in subsequent years for seed increase and eventual distribution as pure seed.

IRRIGATED RICE.

An irrigation plant was installed during the year and the first trial with irrigated rice commenced. The aim was to determine the suitability for flooded cultivation of the varieties at present cultivated under dry land conditions.

VARIETY TRIALS.

As reported last year it was planned to conduct variety trials throughout the Territory. Seed for thirteen simple replicated trials was distributed to selected centres but owing to a series of mishaps practically no results were obtained.

PESTS AND DISEASES.

All rice on the Station was adversely affected by drought, with poor flowering and many sterile heads. On much of the crop the glumes turned purple, apparently as a direct result of drought conditions.

Leptocoryza varicornis was not serious although present on all trials. The stem borer (*Diachraea* spp.) was a minor pest in the dry rice but caused major damage in the irrigation bays, especially on the varieties Toentoeng, Blue Bonnet, and Anbar Bau. Pyraustid leafroller was also more prevalent on the rice under irrigation than on the dry land crops. *Helmonthosporium oryzae* and *Ramularia* sp. infections were again slight.

ABACA (MANILA HEMP) (*Musa textilis*).

The clone x spacing trial planted in 1959-60 took poorly and a further shipment of planting material from Keravat was obtained to fill in the gaps. However, the very dry conditions at planting time militated against success and the trial is still not complete. The initial plantings are now well established.

CASHEW NUT (*Anacardium occidentale*).

As recorded in 1959-60, two thirds of the block was destroyed by flooding. Most of the misses were filled this year. The original trees yielded a small crop and are now flowering well for the next crop.

COTTON (*Gossypium hirsutum*).

The variety x spacing x time of sowing experiment of last year was to be repeated this year. However, by planting time, the seed supplied for this trial was inviable with the result that plantings failed completely.

CASTOR BEAN (*Ricinus communis*).**SEED PRODUCTION.**

Five varieties of castor bean were planted in isolated plots for seed production. They were:

NG 4370 variety R 63.—Two types were distinguishable in this variety, namely, a tall green stemmed type with spined indehiscent capsules, and a short red stemmed type with spineless indehiscent capsules. Both had a maturation period of four months. Seed of the two types was separated.

NG 4386 variety SMFC.—This was supposedly a tall drought-resistant hybrid with spined indehiscent capsules. It was, however, very mixed, and six types were isolated on the basis of stem colour, height and capsule characteristics. The maturation period was between four and five months.

NG 4388 variety UC 53.—A tall green stemmed variety with spined indehiscent capsules and a maturation period of four months.

NG 4530 variety Mauthners Dwarf.—A short red stemmed variety with spineless indehiscent capsules. Maturation period four months. Yielded 1,093 lb. to the acre.

NG 4815.—A medium height (5 ft.) red stemmed variety with spineless indehiscent capsules and a four-month maturation period. Yielded 760 lb. to the acre.

VARIETY TRIAL.

A variety trial was conducted using a randomized block design with three replications of eleven varieties. Three varieties failed to germinate and with a further three only one replication germinated.

The results are given in Table 46.

TABLE 46.—CASTOR BEAN VARIETY TRIAL, EPO.

Variety.				Yields in ounces (in the capsule).					Yields in lb. per acre.
				Replications.			Total.	Mean.	
4059	..	..	..	272	..	..	272	272	1,646
4369	..	..	..	208	..	..	208	208	1,258
4386	..	..	..	166	144	176	486	162*	980
4388	..	..	..	128	208	112	448	149*	901
4058	..	..	..	96	..	..	96	96	581
4387	..	..	..	35	35	37	107	36*	218
4389	..	..	..	34	38	28	100	33*	200
4370	..	..	..	11	28	17	56	18.6*	112

* Least significant difference of means 5 per cent. level, 62; 1 per cent. level, 79; 0.1 per cent. level, 91.

As the variation between replications with the five replicated varieties was not high, it may be assumed that the single replications of the varieties NG 4059, 4369, 4058 gave reasonable indications of their yielding ability. The varieties NG 4059 (Baker 296 Dwarf), NG 4369 (S 367), NG 4386 (SMFC), NG 4388 (UC 53) yielded well, with NG 4058 (Cimarron Hybrid) in an intermediate position. The remainder, namely NG 4387 (SMFGR), NG 4389 (Saphir) and NG 4370 (R 63), were poor yielders.

COFFEE (*Coffea canephora*).

The five acre block of robusta coffee (Besoeiki strain) planted out in April, 1960, continued to progress satisfactorily. The temporary shade trees (*Crotalaria anagyroides*) were removed during the year, leaving permanent shade trees (*Leucaena glauca*), well established.

A polyclonal seed garden, using material supplied by Keravat, was established. The clones planted were:—K1, K3, K4, K5, K6, K7, K9, K10, K11, and K57. K2 and K55 have still to be supplied.

COCONUTS (*Cocos nucifera*).

Eighty coconuts of the high yielding variety "Rotuma" received from the Department of Agriculture, Suva, Fiji, were planted in a nursery, and during the coming wet season will be planted out in the field in an isolated seed garden. Germination of the nuts was 50 per cent.

LEGUMES.

There are now thirty-one legume accessions under observation with regard to their potential as shade, smother, pasture and green manure crops, as follows:

Accession Number.	Variety.	Accession Number.	Variety.
NG 1973	.. <i>Phaseolus lathyroides</i>	NG 3944	.. <i>Tephrosia vestita</i>
NG 1981	.. <i>Phaseolus calcaratus</i>	—	.. <i>Tephrosia candida</i>
NG 2704	.. <i>Pueraria phaseoloides</i>	NG 1955	.. <i>Clitoria ternatea</i>
NG 3122	.. <i>Pueraria phaseoloides</i>	NG 4933	.. <i>Vigna sinensis</i>
NG 3121	.. <i>Centrosema pubescens</i>	NG 3920	.. <i>Crotalaria striata</i>
NG 3036	.. <i>Centrosema pubescens</i>	NG 1268	.. <i>Crotalaria goreensis</i>
NG 3136	.. <i>Centrosema plumerii</i>	NG 2191	.. <i>Crotalaria spectabilis</i>
NG 3930	.. <i>Indigofera sumatrana</i>	—	.. <i>Crotalaria anagyroides</i>
NG 3932	.. <i>Indigofera suffruticosa</i>	NG 3926	.. <i>Cassia tora</i>
NG 3416	.. <i>Indigofera suffruticosa</i>	NG 3937	.. <i>Sesbania spicosa</i>
NG 3637	.. <i>Indigofera hirsuta</i>	NG 2981	.. <i>Cajanus cajan</i>
NG 2589	.. <i>Dolichos lablab</i>	NG 3115	.. <i>Mimosa invisa</i>
—	.. <i>Calopogonium mucunoides</i>	NG 4841	.. <i>Glycine javanica</i>
NG 3939	.. <i>Flemingia congesta</i>	NG 4747	.. <i>Canavalia sp.</i>
NG 2232	.. <i>Tephrosia vogelii</i>	—	.. <i>Pachyrhizus tuberosus</i>
NG 3942	.. <i>Tephrosia notiflora</i>		

LEUCAENA HYBRIDS.

Nine *Leucaena* hybrids are under trial as shade trees. Owing to the dry season, their establishment was poor.

They are listed hereunder:

- NG 4384 *L. leucocephala* (glauca) x *L. pulverulenta*, Leucaena Pantai 10.
- NG 4385 *L. leucocephala* (glauca) x *L. pulverulenta*, Leucaena Pantai 22.
- NG 4498 *L. leucocephala* (glauca) x *L. pulverulenta*, Strain Pob (Pobaim 104).
- NG 4499 *L. leucocephala* (glauca) x *L. pulverulenta*, Strain PA 7 (Pantai).
- NG 4500 *L. leucocephala* (glauca) x *L. pulverulenta*, Strain Pantai 10.
- NG 4501 *L. leucocephala* (glauca) x *L. pulverulenta*, Strain Pantai 19.
- NG 4502 *L. leucocephala* (glauca) x *L. pulverulenta*, Strain Pantai 22.
- NG 4503 *L. leucocephala* (glauca) x *L. pulverulenta*, Strain Pantai 43.
- NG 4505 *L. leucocephala* (glauca) x *L. pulverulenta*, Strain Sarmaikrang 73.

MAIZE (*Zea mays*).

Five varieties of maize resistant to the rust *Puccinia polysora* were grown for observation and seed production. The results were as follows:

NG 4341 Variety Tanag No. 1. White dent. This variety was planted on 20th January and harvested on 11th May (112 days) to yield 1,620 lb. per acre on the cob. Approximately 4 per cent. of the crop was infected with rust, but there were no fully susceptible plants.

NG 4342 Variety Tanag No. 2. White flint. This variety was planted on 28th January and harvested on 12th April (78 days) to yield 17,754 lb. per acre on the cob. The cobs were about 10 inches in length, well filled with large grains in even rows. Approximately 3 per cent. of the crop was infected with rust, but there were no fully susceptible plants.

NG 4345 Variety Improved Katumbili. This variety was planted on 24th January and harvested on 12th April (78 days) to yield 28,291 lb. per acre on the cob. The cobs were about 9 inches in length, well filled with even rows of flint type grain. Approximately 3-5 per cent. of the crop was infected with rust, but no plants were fully susceptible.

NG 4358 Variety 24. Rust Resistant Maratha. This variety was planted on 12th January and harvested on 24th April (103 days) to yield 7,156 lb. per acre on the cob. The cobs were long, thin and well filled. Approximately 26 per cent. of the crop was infected with rust but no plants were fully susceptible.

NG 4359 Variety 29. Rust Resistant K 8. This variety was planted on 9th January and harvested on 11th April (93 days) to yield 11,780 lb. per acre on the cob. Approximately 25 per cent of the crop was infected with rust but no plants were fully susceptible.

OIL PALM (*Elaeis guineensis*).

Genetic stocks introduced the previous year from Malaya were still in the nursery. Ground was prepared for planting in the field during the coming wet season.

PEANUT (*Arachis hypogaea*).

This station now maintains 79 peanut varieties, which were grown for observation and yield testing. They have not reached maturity and owing to late planting and dry seasonal conditions, yields are expected to be poor. Fungal disease and insect pests did not cause any notable damage, but all varieties appeared to be infected with an unidentified virus disease.

SISAL (*Agave sisalana*).

A sisal block was established from bulbils introduced from Bubia Agricultural Station and planted in the nursery last year. Growth has been poor under the extremely dry conditions prevailing since planting out in the field.

SORGHUM (*Sorghum vulgare*).

NG 4838 Variety Sugardip, the only variety planted to germinate, was severely attacked by rust. It matured in three months to yield 1,017 lb. per acre of unthrashed grain.

SOY BEAN (*Glycine max*).

Thirteen varieties of soy bean were planted in an unreplicated trial (lack of seed prevented any replication) at the beginning of the wet season (early January). Germination commenced at five to seven days, first flowering occurred at 40 to 45 days and maturity was reached within 90 days of planting with the exception of NG 4668 which matured slightly later. All varieties were seriously damaged by insects. Satisfactory control was obtained using 0.05 per cent. dieldrin spray. Two varieties, NG 4672 and NG 4540, did not survive to maturity. Results for the other varieties are shown in Table 47.

TABLE 47.—SOYBEAN VARIETY TRIAL, EPO.

Variety No.	Name.	Yield in Pod (lb. per acre).	Seed Colour.
NG 4660	999	87	Black
NG 4661	Batavian Yellow	3,091	Black
NG 4662		702	Black
NG 4663	Avoyelles	637	Yellow
NG 4664	C.N. 5	1,852	Yellow
NG 4665	Glycine 317	1,624	Yellow
NG 4666	Hernon 49	527	Yellow
NG 4667	Mamloxi	3,020	Yellow
NG 4668	Mamloxi 57/5	1,770	Yellow
NG 4669	Avoyelles	2,224	Yellow
NG 4670	SHE 30	255	Black
NG 4671	Riggit	680	Yellow
NG 4690	Jackson	639	Yellow

TOBACCO (*Nicotiana tabacum*).**VARIETAL TRIALS.**

Tobacco was introduced to the Station this year. The first planting was made in October, 1960. Two crops were grown, the first under natural rainfall assisted by irrigation in the initial stages, and the second entirely under irrigation.

The first crop comprised three varieties, KY 160, KY 151, and Hicks. The first two were heavy leaf types suitable for twist tobacco production and appeared to be identical. Hicks was a lighter leaf type and thus less suitable for twist production. Moreover it was badly infected with frog-eye leaf spot (*Cercospora nicotianae*), and the leaf produced was not suitable for commercial use. The KY varieties were infected to a lesser extent, but even so, quality was seriously impaired.

All varieties were attacked by the Corn ear worm caterpillar (*Heliothis armigera*).

After curing and sorting (as a result of insect damage half the original leaf was discarded) KY 160 yielded 300 lb. to the acre and KY 151, 250 lb. to the acre. These yields were somewhat disappointing, especially as the size and number of leaves had appeared most promising in the early stage of the crop.

The second crop, which contained only the single variety NG 4742, Improved Yellow Mammoth, was grown entirely under irrigation. The growth was very encouraging, but again there was a heavy infection of *Cercospora* leaf spot. Maturity of the crop was very uneven, probably owing to poor water control. The crop is now undergoing curing.

CONTROL OF PESTS AND DISEASES.

Corn ear worm caterpillar, *Heliothis armigera*, was the only insect pest causing significant damage to the crops. Control was effected by weekly spray of D.D.T. at 1 per cent. Endrin at 0.05 per cent., or Dieldrin at 0.05 per cent. BHC dust (6 per cent.) also gave effective control.

Frog-eye leaf spot, *Cercospora nicotianae*, was the main disease and has not been fully controlled. The control measure first adopted was the application of copper oxychloride weekly at 4 lb. per 100 gallons of water. This resulted in burning of the leaves and the concentration was halved; this eliminated leaf burning but no longer controlled the disease.

Rhizoctonia solani occurred on isolated plants but was of minor importance. Attention to drainage reduced its incidence satisfactorily.

NURSERY PRACTICE.

Four nursery beds, each 10 ft. x 5 ft., were built 4 inches above ground level with ditches surrounding their borders to ensure adequate drainage. The beds were dug out to a depth of 8 inches below ground level and filled first with river gravel and then with a mixture of river sand and the local surface soil, together with a quantity of ashes.

Prior to sowing, the beds were treated with "Vapam" soil fumigant. The seed was sown mixed with water through a watering can.

Shading the beds was found to have no other effect than to reduce the amount of watering necessary and the practice was therefore abandoned, in line with Australian practice.

FIELD PRACTICE.

Transplanting into the field was carried out at 6 to 8 weeks after sowing. Transplants were placed on the edge of irrigation furrows dug at 4-ft. intervals so that the plant was just above the water level in the furrow: planting distance along the furrow was 3 feet.

Priming was not carried out initially, but has become necessary as a means of controlling leaf spot.

Topping was carried out when approximately 75 per cent. of the crop was in flower. It was found necessary to top twice. Desuckering was a continuous process thereafter.

Harvesting commenced at 11 weeks from planting in the field for the varieties KY 160 and KY 151, and 13 weeks from planting in the field for the variety Improved Yellow Mammoth. Up to four harvests were necessary.

BARNs.

Two barns were constructed, the first being 12 ft. x 12 ft. x 15 ft. high and the second 12 ft. x 16 ft. x 15 ft. high. Both had corrugated iron walls and roof with earth floor. The walls were vertical, the roof flat and a 6-ft. ventilation space was provided below the roof, with provision for closing when necessary. The fire was situated in the centre of the floor with an iron sheet baffle above at a height of four feet.

The leaf was hung in 3 tiers 3 feet apart, with the bottom one 6 feet from the floor. In the tiers, the sticks on which the leaf was hung were spaced 12 inches apart and approximately 30 leaves were hung per foot.

CURING.

The leaf was smoke cured over an open fire. After a certain amount of experimenting the following curing procedure was adopted:

- (i) First day. Harvest the leaf and hang in the barn. Dampen the floor to increase humidity.
- (ii) Second day. Leave barn undisturbed to allow uniform yellowing under high humidity with no heat.
- (iii) Third day to nineteenth day. Maintain a small fire, increasing gradually to 140° F. to give a steadily declining humidity with increasing temperature.
- (iv) Twentieth day. Leave the leaf in the barn to gather moisture from the atmosphere to enable it to be handled without damage.
- (v) Bulk leaf down for about four weeks and then bale.

Eucalypt timber was the most satisfactory fuel. It did not produce dense smoke but burned with a slow hot fire, necessary for thorough curing. Sawdust, which may be useful for increasing the volume of smoke, was unavailable.

RUBBER SECTION, BISIANUMU.

The layout of the rubber section of Bisianumu was described in the 1959-60 Annual Report and is illustrated in Figure 8.

There were no major new developments during the year but experiments in progress continued steadily.

BUDWOOD NURSERIES.

New multiplication plots of clones expected to be in great demand were established. The older plots were reduced to the minimum number of trees required to supply anticipated demand for budwood.

One more clone was imported from the Rubber Research Institute of Malaya, bringing the total to 59.

MUSEUM PLOTS.

The area of museum plots was extended by the clearing of some twelve acres of secondary bush. In this area old terraces were reconditioned and seedling stock planted for future budgrafting.

The area set aside for museum plots is now approximately twenty acres, of which eight acres has been planted with 24 different clones. Growth is generally satisfactory; all trees were fertilized during August, 1960.

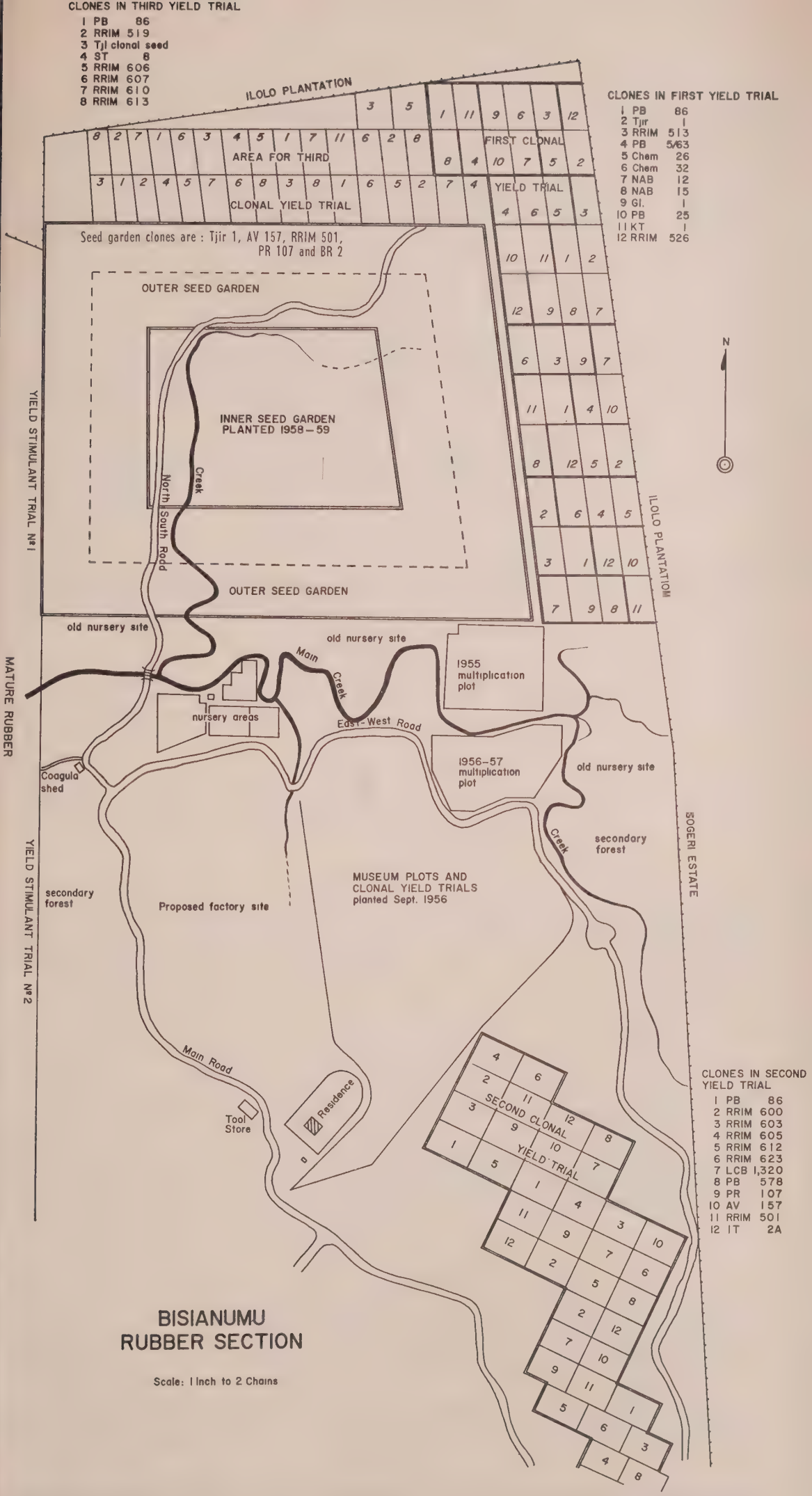


Figure 8—Plan of the Rubber Section, Bisianumu.

CLONAL SEED GARDEN.

Development of the 40 acres of clonal seed garden continued normally, growth being satisfactory except for one section in the north-west corner of the outer seed garden, which is on a rather eroded ridge.

Trees are now in their second and third year after planting, except for one small part on the southern side of the outer seed garden which is now in its fourth year. All trees were fertilized during August, 1960, and the trees in the north-west corner and in the inner seed garden were again fertilized during April, 1961.

CLONAL YIELD TRIALS.

FIRST CLONAL YIELD TRIAL.

This trial, comprising twelve clones of 200 trees per clone in four replications, each of 50 trees, was planted during March, 1959. The trees are now in their second year since planting and progress is satisfactory.

SECOND CLONAL YIELD TRIAL.

The fourth replication was planted with budded stumps during March, 1961, thus completing the trial. It comprises twelve clones of 240 trees per clone in four replications, each of 60 trees.

THIRD CLONAL YIELD TRIAL.

Budgrafting in the field on two-year-old seedlings for the third clonal yield trial commenced in June, 1961. It contains seven clones and Tjir 1 monoclonal seedlings, in four replications of 50 trees per replication.

YIELD STIMULANT TRIALS.

Records were continued throughout the year, but no final interpretation of the results has yet been attempted.

NURSERIES OF SEEDLING STOCKS.

New nurseries were established during March, 1961, containing approximately 6,000 seedling-stock for future budgrafting operations.

BUDGRAFTING COURSE.

Thirty-eight plantation workers were trained in two successive courses during May and June. Trainees were taught principles and techniques of budgrafting, nursery work, stumping, transplanting and after-care of budgrafts—in short, they were made familiar with all aspects of handling improved rubber planting material.

PLANT INDUSTRY CENTRE, BUBIA.

The greatest progress at Bubia this year was in pasture introduction and testing. The most promising introduction was a strain of the legume *Phaseolus atropurpureus*, known as Siratro, bred and released by the Commonwealth Scientific and Industrial Research Organization of Australia. Siratro in the environment at Bubia had a very vigorous creeping and climbing habit, rooting at the nodes, and recovered quickly after grazing. It also flowered and seeded lightly throughout the year if not cut or grazed too heavily.

The following progress report is made on current investigations.

SISAL (*Agave sisalana*).

The sisal work at Bubia is now essentially a holding operation, there being no current commercial interest in the crop. Planting material is being maintained together with plots in selected areas to test representative environments for ecological suitability where there appears to be some potential for sisal growing.

The growth of sisal at Bubia is illustrated in Plate 15 and fibre production from local plantings in Plate 16.

CACAO (*Theobroma cacao*).

The trials designed to elucidate the nature and control of the obscure die-back condition reported in 1959-60 are outlined below.

SOIL FERTILIZER APPLICATION TO MATURE CACAO.

The following treatments were applied in August, 1959, to mature cacao in an effort to alleviate the conditions of "Die-back" and minor element deficiency symptoms, and to rehabilitate the stand:

- (i) Control.
- (ii) Sulphur, 1 ton per acre.
- (iii) Sulphur, 1 ton per acre.
Nitrophoska Red (NPK mixture), 4 cwt. per acre.
Phytone (complete minor-element mixture of Mg, Zn, Cu, B, Mn, Fe, Mo), 1½ cwt. per acre.
- (iv) Sulphate of ammonia, ½ ton per acre.
- (v) Sulphate of ammonia, ½ ton per acre.
Superphosphate, 2½ cwt. per acre.
Muriate of Potash, 1 cwt. per acre.
Phytone, 1½ cwt. per acre.

Plots consisted of nine trees. All pods were removed at the time of application of the fertilizers. Pod counts of each plot were taken at approximately monthly intervals from the time of recommencement of bearing.

The results were disappointing. The sulphur treatments produced a mean drop in pH of 1.2 units at 0-8 inches. Sulphate of ammonia produced a drop of 0.8 units. The pH of the original soil was 6.5-7.5 at 0-8 inches.

There was no response in yield to any of the treatments. A number of unthrifty trees died from root rot, and some from severe die-back. The difficulty in preventing damage from *Pantorhytes* and mealy bugs would have contributed to the variability of the recorded yields. The trial in its present form has been abandoned.

CUTTING BACK TRIAL.

A block of 15 ft. x 15 ft. square-planted mature cacao was divided into 9-tree plots, with guard rows. The plot trees were pollarded heavily in January, 1960, to induce a flush of new growth. The following treatments were sprayed on to the new leaf growth:

- (i) Water only (control).
- (ii) Zinc sulphate, 1 oz. per gallon of water.
- (iii) Copper sulphate, 1 oz. per gallon.
- (iv) Zinc sulphate, 1 oz. + copper sulphate, 1 oz. per gallon.
- (v) Phytone (complete micro-element mixture) 4 oz. per gallon.

There were three replications.

Results were again negative. A number of mature trees, especially those in an unthrifty condition, failed to recover from the heavy pruning. In the initial flush there were no deficiency symptoms on any plot, except for a few leaves here and there showing faint chlorosis which could have been iron or manganese deficiency. At one stage it appeared that trees in Treatment (v) were producing bigger flushes, but the difference was not substantial and later disappeared. Infection by *Botryodiplodia theobromae* and subsequent die-back of branches was not prevented entirely by any treatment, nor did the incidence of die-back appear to be any greater on the control plots than on the others. The trees have recently started bearing again, and yields will be recorded.

MINOR ELEMENT SPRAYING TRIAL—SUAMBU PLANTATION.

A block of seedling cacao about eighteen months old was made available for experimental purposes on Suambu plantation and a randomized block experiment was commenced in October, 1960. There were four replications of the following treatments:

- (i) Control.
- (ii) Zinc sulphate spray.
- (iii) Copper sulphate spray.

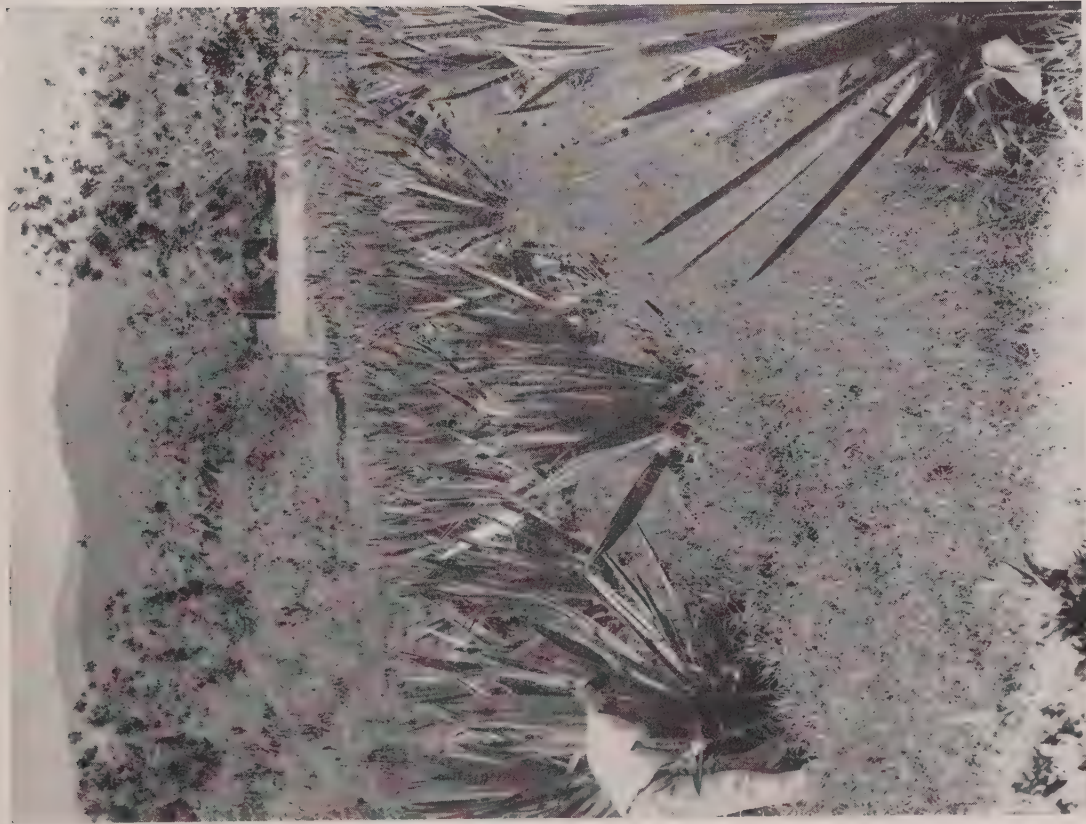


Plate 15—The original sisal planting at Bubia.

[Photo : D.I.E.S.]

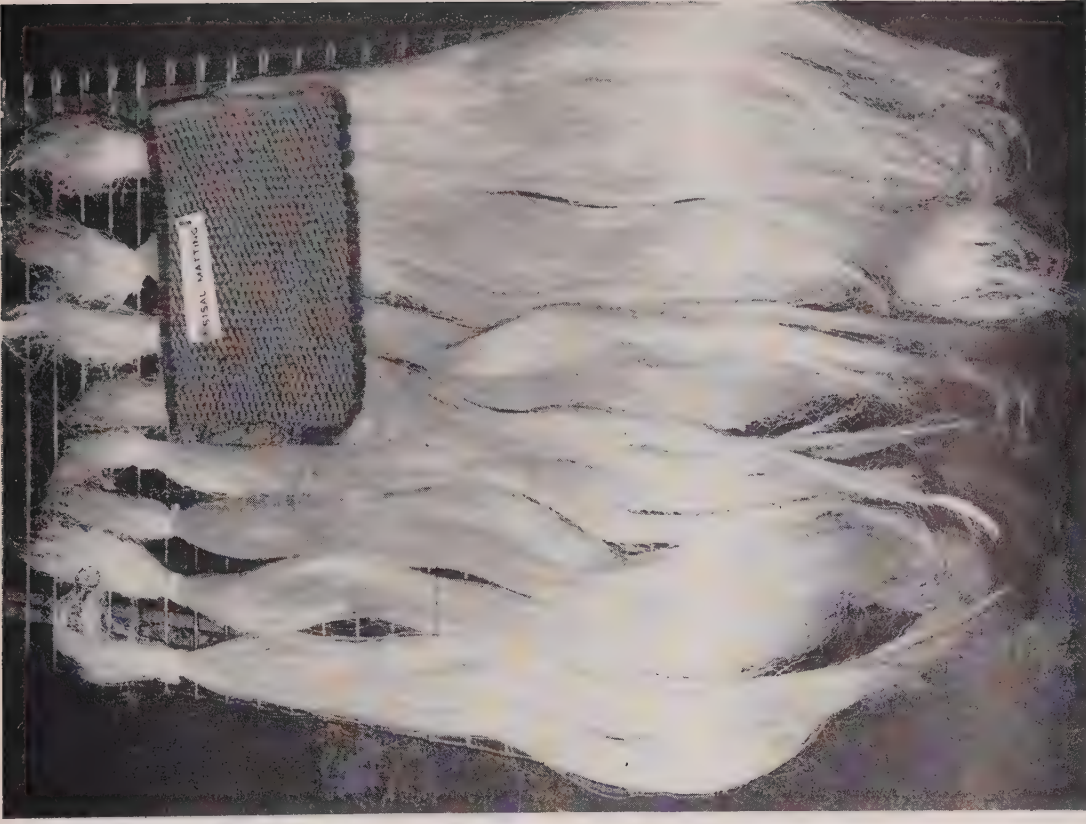


Plate 16—Sisal fibre from Bubia is of good colour and quality.

[Photo : D.I.E.S.]

- (iv) Zinc sulphate + copper sulphate spray.
- (v) Zinc sulphate + copper sulphate + borax spray.
- (vi) Phytona (complete minor element mixture) spray.
- (vii) Phytona plus soil application of nitrogen, phosphorus, and potassium.

Rates: Zn — $\frac{1}{2}$ oz. per gallon zinc sulphate.

Cu — $\frac{1}{2}$ oz. per gallon copper sulphate.

B— $\frac{1}{2}$ oz. per gallon borax

Phytona—4 oz. per gallon.

NPK—1 lb. Nitrophoska per plant per year (first year).

Each plot consisted of a single row of twenty trees with guarding. The treatments were sprayed on to new flush leaves every month by means of pressure knapsacks. The whole area was sprayed periodically with malathion and white oil to control mealybugs. Two of the four replications were sprayed at approximately fortnightly intervals with thiotox (T.M.T.D.) fungicide to study its effects on the incidence of "die-back".

All treatments containing zinc showed a reduction of characteristic sickle-leaf symptoms. The Phytona treatment appeared to be slightly less effective, probably because of the lower relative percentage of zinc sulphate. Girth measurements did not show up any marked growth responses, but these data have not yet been analyzed statistically.

SEEDLING SPRAYING TRIAL, BUBIA.

A small spraying trial on 6-month-old cacao seedlings was commenced at Bubia in October, 1960. There were two treatments, control and Phytona at 4 oz. per gallon. The Phytona was applied with a pressure knapsack spray to the new flush leaves. Plots consisted of nine trees, with guarding. There were four replications.

Trunk diameter measurements have not revealed any response to Phytona, but zinc deficiency symptoms in the new leaves have been reduced.

PASTURE INVESTIGATIONS.

The pasture species introduced during the year and planted in observation plots at Bubia are shown in Table 48.

TABLE 48.—PASTURE SPECIES INTRODUCED TO BUBIA.

Name.	Number.	Source.
1. <i>Cenchrus ciliaris</i> (Molopo strain)	N.G. 4848	South Africa
2. <i>Desmodium intortum</i>	..	C.S.I.R.O.
3. <i>Desmodium uncinatum</i>	CPI 8890	C.S.I.R.O.
4. <i>Eragrostis chloromelas</i>	N.G. 4853	South Africa
5. <i>E. curvula</i>	N.G. 4854	South Africa
6. <i>Glycine javanica</i>	N.G. 4841	South Africa
7. <i>G. javanica</i> (Kairi strain)	..	C.S.I.R.O.
8. <i>Lotononis bainesii</i>	CPI 16833	C.S.I.R.O.
9. <i>Panicum coloratum</i>	N.G. 4850	South Africa
10. <i>Paspalum urvillei-virgatum</i>	N.G. 4847	South Africa
11. <i>Paspalum plicatulum</i>	CPI 2741	C.S.I.R.O.
12. <i>Pennisetum purpureum</i>	N.G. 4837	South Africa
13. <i>Phalaris tuberosa</i> var. <i>stenoptera</i>	N.G. 4851	South Africa
14. <i>Phaseolus atropurpureus</i> (Siratro)	..	C.S.I.R.O.
15. <i>Setaria sphacelata</i>	CPI 17795	C.S.I.R.O.

Digitaria decumbens (Pangola grass) grew well when first planted in an observation plot, but has deteriorated somewhat since, becoming tufted and stemmy. Close grazing would probably prevent this condition. A small area at Erap which was grazed periodically by cattle was apparently very palatable, but exhibited nitrogen deficiency symptoms. This species was attacked by a leaf-eating beetle (*Aulacophora similis*), and also by a root-sucking insect (unidentified). Under grazing conditions the leaf-eating beetle would probably not be important. Aldrin quickly eradicated the root-sucking insects and associated ants at Bubia. They were not observed at Erap.

Paspalum plicatulum (CPI 2741) showed promise. In sub-tropical Queensland this grass is superior in nutritional value to *Cenchrus ciliaris*, *Panicum maximum* var. *trichoglume*, *Paspalum commersonii* and *Chloris gayana*. Another strain (CPI 11826) is apparently superior to this strain in Queensland and will be introduced shortly. The species is not stoloniferous, somewhat tufted, growing to about three feet. In this environment it seeded lightly about two months after planting or cutting back.

Phaseolus atropurpureus ("Siratro") was particularly interesting. This legume, specially bred by C.S.I.R.O., was introduced in January, 1961. It has a very vigorous creeping and climbing habit, rooting at the nodes. In this environment it recovered quickly after close grazing or mowing, and flowered and seeded lightly during most of the year if left uncut. Siratro is one of the most promising pasture legumes yet introduced. As it is cleistogamous the original hybrid vigour of the bred strain should be maintained in the progeny.

Glycine javanica (Kairi strain) was another vigorous creeping and climbing legume, planted in January, 1961, but the growth rate was not as high as that of Siratro. To date it has not produced any flowers.

Lotononis bainesii, which has been most successful in South-east Queensland, requires a specific *Rhizobium* strain for maximum productivity. At Gusap, a plot of *Lotononis* grew vigorously after inoculation of the seed with the correct *Rhizobium*. In the trial plot at Bubia, however, growth was very slow, the plants small and stems spindly. The plants had pink nodules, but when specimens were sent to the Pathology Section for checking, they were unable to isolate *Rhizobium*.

As mentioned in the 1959-60 report, an area of land at Erap Animal Industry Station has been set aside for introductory trials and multiplication plots. A $\frac{1}{4}$ -acre plot was sown with Siratro seed obtained from the Bubia plot. The area was subdivided into six plots, and three grasses were oversown, namely *Chloris gayana* (commercial strain Rhodes grass), *Dicanthium sericeum*, N.G. 2342 and *Melinis minutiflora* (molasses grass).

COTTON (*Gossypium hirsutum*).

COTTON VARIETY x SPACING x TIME OF SOWING TRIAL, ERAP.

In March, 1960, a cotton trial was laid down at Erap incorporating six varieties of *Gossypium hirsutum*, at three spacings, and planted on three sowing dates. There were three replications.

There was excessive vegetative growth in the first and second sowings. The first sowing of all varieties was 4-6 feet high and was practically impenetrable when fully grown. The third sowing was smaller and less dense at maturity. There was very little flowering during the entire growth period, probably a reflection of the very vigorous vegetative growth. There are several suggested reasons for this lack of flowering and consequent poor boll set:

- (i) Twenty-eight inches of rain fell during the eight months of growth. The rain fell fairly evenly during the whole period, resulting in a poor environment for flowering and boll setting.
- (ii) The soil was a fertile sandy loam, which had supported only native grasses and weeds for a number of years. After ploughing and cultivation a high nitrogen content may have contributed to the excessive vegetative growth.
- (iii) Insect depredations were heavy, and though fair control was obtained with the use of D.D.T. and Endrin, the number of bolls setting was even further reduced.

There was not enough cotton produced to warrant recording of yields. The plants were removed at the end of October, 1960. Another trial is projected further up the Markham Valley where there is a more marked dry season.

MAIZE (*Zea mays*).

A trial was carried out at Bubia to test the resistance to *Polysora* rust and the yield potential of six introduced varieties from Africa.

The trial was planted on the 3rd January, 1961, with four rows of each variety, two of the rows being fertilized with the equivalent of 350 lbs. of Nitrophoska Yellow per acre.

The varieties under trial were:

- N.G. 4343 Tanag No. 1.
- N.G. 4344 Tanag No. 2.
- N.G. 4360 Variety 24 Rust Resistant K8.
- N.G. 4365 Afro. 30 Maratha.
- N.G. 4358 Variety 24 Rust Resistant Maratha.
- N.G. 4359 Variety 29 Rust Resistant K8.

The results are recorded in Table 49.

TABLE 49.—YIELD AND RUST RESISTANCE OF SIX INTRODUCED MAIZE VARIETIES.

Variety.	Treatment.	Rust Resistance.	Tentative Rating.	Weight of Shelled Grain. (lb.)
N.G. 4343	Unfertilized ..	Resistant spots. No spores	R	26.50
	Fertilized ..			38.75
N.G. 4344	Unfertilized ..	Resistant. No spores	R	23.25
	Fertilized ..			21.25
N.G. 4360	Unfertilized ..	Pustules with spores	MS	26.75
	Fertilized ..			23.75
N.G. 4365	Unfertilized ..	Pustules with spores	MS	23.25
	Fertilized ..			27.75
N.G. 4358	Unfertilized ..	Resistant spots. No spores	R	31.75
	Fertilized ..			36.50
N.G. 4359	Unfertilized ..	Pustules with abundant spores	S	16.25
	Fertilized ..			27.75

Owing to the nature of the trial no statistical analysis could be carried out but apart from a few anomalies the results seem fairly straightforward, showing the two varieties N.G. 4343 and N.G. 4358 to be the most promising.

CASTOR BEAN (*Ricinus communis*).

A variety x fertilizer trial was planted on the 18th December, 1960, with the following varieties:

- N.G. 4386 var. "SMFC".
- N.G. 4387 var. "SMFGR".
- N.G. 4388 var. "UC53".
- N.G. 4389 var. "Saphir".
- N.G. 4369 var. "S 367".
- N.G. 4370 var. "R 63".

There were two rows of each variety, one fertilized and the other unfertilized. Nitrophoska Yellow (NPK) was used at the rate of 300 lb. per acre and the spacing was 6 ft. x 6 ft. square.

Poor germination and lack of vigour resulted in a diminished number of bearing plants in some rows. The maximum number of plants in a row was found to be fifteen and this was used as a basis for yield comparison. The results are shown in Table 50.

TABLE 50.—CASTOR BEAN YIELDS, BUBIA.

Variety.							Treatment.	Yield on a fifteen plants per row basis. (lb.)
N.G. 4386							Unfertilized ..	1.92
							Fertilized ..	2.40
N.G. 4387							Unfertilized ..	2.95
							Fertilized ..	1.77
N.G. 4388							Unfertilized ..	2.24
							Fertilized ..	3.82
N.G. 4389							Unfertilized ..	3.48
							Fertilized ..	2.81
N.G. 4369							Unfertilized ..	3.07
							Fertilized ..	4.39
N.G. 4370							Unfertilized ..	8.35
							Fertilized ..	12.22

The variety R63 (N.G. 4370) exceeded all others in yield. Oil analyses were not carried out. All varieties ripened unevenly at Bubia, which was too wet for good production. A further trial will be sown in the drier environment of Erap, with spacing introduced as an additional variable in view of the large differences in plant size observed at Bubia.

LEMON GRASS (*Cymbopogon* spp.).

A small lemon grass trial was laid down on Bubia to investigate the management problems associated with the commercial cultivation of this crop. The strain growing at Bubia was used initially, but owing to lack of planting material, half the trial was planted with material from Lae. After a few weeks it was noticed that there was a difference in growth habit between the two forms. Only the Bubia species flowered, enabling an identification to be made.

The species growing at Bubia was thought to be *Cymbopogon flexuosus* (Nees Ex. Stend.) Wats., the best source of lemon grass oil. However, Bor (Grasses of India, Burma and Ceylon 1960) recognizes two forms; one with red stems and one with white. The red-stemmed form is now considered to be the true *C. flexuosus*. The white stemmed variety has been named *C. travacoriensis* Bor. and yields an inferior oil not marketable commercially. The Bubia Lemon grass appears to be the inferior white stemmed variety. As this was the only immediately available source of planting material a spacing x time of harvest trial was laid down. The six treatments were as follows:

Treatment.								Spacing.	Harvest Interval.
									months
1	..	..	..	..	..	..	..	2 ft. x 2 ft.	3
2	..	..	..	..	..	..	..	2 ft. x 2 ft.	4
3	..	..	..	..	..	..	..	2 ft. x 1½ ft.	3
4	..	..	..	..	..	..	..	2 ft. x 1½ ft.	4
5	..	..	..	..	..	..	..	2 ft. x 1 ft.	3
6	..	..	..	..	..	..	..	2 ft. x 1 ft.	4

The trial was planted on 21st April, 1961, and a 90 per cent. strike was obtained. Replants were put in on 2nd June. The treatments were replicated six times in a Latin Square design with each plot consisting of four rows 24-ft. long, with additional guard rows.

TABLE 52.—PLANT INTRODUCTION—COUNTRIES OF ORIGIN 1960-61.

<i>America:</i>							
U.S.A.	..	..	..	..	40		
Brazil	..	..	..	..	1		
						..	41
<i>Pacific Region:</i>							
Fiji	..	..	..	..	10		
Netherlands New Guinea	..	..	..	..	1		
						..	11
<i>Asia:</i>							
Ceylon	..	..	..	..	1		
India	..	..	..	..	4		
Indonesia	..	..	..	..	12		
Malaya	..	..	..	..	52		
Philippines	..	..	..	..	11		
						..	80
<i>Africa:</i>							
Nigeria	..	..	..	..	1		
South Africa	..	..	..	..	29		
						..	30
<i>Europe:</i>							
F.A.O. Rome	..	..	..	..	1	..	1
<i>Australia:</i>							
C.S.I.R.O.	..	..	..	..	35		
Department of Health, Canberra	..	..	..	..	4		
Sydney University	..	..	..	..	3		
Department of Agriculture, N.S.W.	..	..	..	..	8		
Department of Agriculture, Qld.	..	..	..	..	7		
Waite Institute	..	..	..	..	2		
Commercial	..	..	..	..	8		
						..	67
						Total	230

TROPICAL FRUITS.

Negotiations for the conclusion of an Inter-Governmental exchange agreement for plant material between Malaya and the Territory continued. The delay in reaching formal agreement held up attempts to introduce a wide selection of tropical fruit trees, most of which have to be vegetatively propagated. A shipment of selected trees was received from Indonesia but unfortunately the majority died after arrival in the Territory.

Four additional peach varieties with low chilling requirement were obtained from Australia and these will supplement the three varieties already under trial in the higher altitude regions of the Western Highlands.

COFFEE.

The coffee industry of the Territory has been able to develop without the handicap of Coffee Rust (*Hemileia vastatrix*), the most serious disease of coffee. It is hoped that this position will be maintained by quarantine measures but as an insurance against possible accidental introduction of coffee rust, resistant varieties from the United States collection are being introduced. So far seven selections have been obtained with known resistance to various strains of rust. Whether directly useful or not they provide a reservoir of useful germ plasm if required.

SPICES.

Additional quantities of the commercial nutmeg *Myristica fragrans* were obtained from Netherlands New Guinea. Small trial plots have been planted in the Western and Gulf Districts of Papua where very little cash cropping has yet been possible.

COCONUT (*Cocos nucifera*).

Two new varieties of coconut, the Rotuma and Fijian Dwarf (Malayan Dwarf x Niu Leka) were received from the Fiji Department of Agriculture.

COTTON (*Gossypium hirsutum*).

Additional cotton varieties from the United States of America were obtained through the C.S.I.R.O.

SOY BEAN (*Glycine max*).

An attempt was made to introduce soy bean varieties which might be adaptable to the Markham Valley and other lowland areas. The introductions from the Philippines were selected mainly for non-sensitivity to photo-period.

RICE (*Oryza sativa*).

Most of the rice varieties introduced belonged to the so-called Bulu rices from Indonesia, which are selections non-sensitive to photo-period effects. They should be particularly suited to Territory conditions but require irrigation, which is not widely available in the Territory.

PASTURE SPECIES.

A fairly large collection of grasses and legumes was introduced from commercial sources in South Africa. They may prove suitable for the drier conditions encountered in parts of Papua.

ONIONS (*Allium cepa*).

Experiments in past years have shown that the onion variety Hybrid Granex Brown is capable of producing good quality onions in most parts of the Territory, especially in the Highlands. Although onions are not regarded as a lowland crop this variety has produced well even at Bomana near Port Moresby when sown to mature at the peak of the cool season. There is scope for the development of a sizeable onion industry in the Territory as imports are close to 1,000,000 lb. per year. The main difficulty in developing an onion growing industry by Native producers is the problem of seed. Hybrid Granex Brown is a true F.1 hybrid so that fresh seed must be imported at considerable expense for each crop. Accordingly short day onion varieties of non-hybrid character developed in South Africa have been introduced for testing.

SORGHUM ALMUM.

There has been considerable interest and controversy in recent years in Australia over the culture of *Sorghum alnum*, a species developed in the Argentine for fodder in areas with low to medium rainfall. It has performed well in Australia but crosses freely with *Sorghum halepense* (Johnson grass), the latter being cyanogenic and having stoloniferous roots, which properties make it a bad weed which is difficult to eradicate. The cross between *S. alnum* and *S. halepense* has the properties of the latter and the seed of the two species is practically identical. Attempts have been made to develop a variety of *S. alnum* with green glumes which would enable it to be distinguished from the black seeded *S. halepense*, but the green glumed variety proved to be much less vigorous than the black glumed type, and any programme to produce a good green glumed variety will clearly have to be long term.

In view of the danger with cross pollination with *S. halepense*, which is already present in the Territory, the importation of *S. alnum* seed was originally prohibited pending the production of green glumed strains. As this objective will not now be attained, at least for some time, the decision was made to introduce pedigreed Johnson grass-free strains of *S. alnum* for multiplication at Laloki where there is no *S. halepense* and thus make the Territory independent of outside seed supplies which might be contaminated.

CACAO (*Theobroma cacao*).

In order to bring in additional germ plasm for the cacao breeding programme, a start was made to introduce cacao material from the Amazonian selections now being grown in Trinidad. As Trinidad is in the "American Tropics" as defined in the Regional Plant Protection Agreement for South-East Asia and the Pacific Region, from which the introduction of living plant material is severely restricted, alternative sources of plant material were investigated. One such source was Fiji which has a collection of cacao clones including some Amazonian clones from Trinidad. The authorities in Fiji were most co-operative in making material available but as their clones were introduced from Trinidad to Fiji in vegetative form it was decided that the Territory would not risk direct introduction. The material introduced to Fiji had undergone a period of intermediate quarantine at Kew in England but it was considered that various symptoms might still be missed under these conditions which would not necessarily favour their expression. The co-operation of the Plant Introduction Section of the C.S.I.R.O. was therefore sought, and this Section agreed to grow rooted cuttings from Fiji in the glasshouse at Canberra and send seed produced from them to the Territory. The clones NA 32 and PA 35 were established at Canberra.

In order to widen the range of Amazonian material available, negotiations were opened with the Imperial College of Tropical Agriculture, Trinidad, with a view to obtaining seed of the best families. Arrangements are in hand to introduce the four Amazonian families at Trinidad, namely Scavina, Nanay, Parinari and Iquitos.

SUGAR CANE (*Saccharum officinale*).

Four commercial sugar cane varieties from Queensland were introduced in order to test their adaptability to the local environment and to provide healthy planting material should a decision be made to establish commercial sugar cane in the Territory.

PLANT QUARANTINE SERVICES.

The Plant Quarantine Service was maintained throughout the year. All plant material entering the Territory by air was inspected at the airport of entry, usually at Port Moresby or Lae. Plant material imported by sea was inspected at the port of entry and excellent co-operation with the Customs Department was effective in intercepting a number of prohibited or quarantinable imports. The amount of plant material imported is increasing in volume and variety. As plants originating from countries other than Australia are becoming more numerous, the need for quarantine vigilance is also increasing.

A New Guinean was appointed to the section for training as a plant quarantine assistant and a Papuan who has been working in the Plant Introduction Section for nearly ten years was gazetted as a Quarantine Officer (Plants), according him full legal powers under the Quarantine Ordinance. This is the first instance in the Department, and probably in the Administration, of a Papuan being gazetted to a statutory position with such powers.

Notices and posters received as part of the Commonwealth-wide publicity campaign setting out the Australian Plant Quarantine Regulations as they affect this Territory were distributed and displayed at all major ports and airports for the information of the public. In turn the Commonwealth authorities have arranged to display Territory Plant Quarantine notices in all ports and airports in Australia whence travellers depart for Territory destinations.

EXPERIMENTAL PLOTS, YAMBI.

Owing mainly to staffing problems, cattle were not introduced to Yambi and there is no significant progress to report.

PLANT PATHOLOGY.

The range of species covered and the number of cultures of *Rhizobium* supplied were both increased.

Several previously undescribed virus diseases were studied and the physical properties of the causal agents determined. None of these virus diseases was of major commercial importance.

A new fungal disease of bananas was described. It is not of major commercial importance.

The sectional reports are given below:

MICROBIOLOGY.

MAINTENANCE AND SUPPLY OF RHIZOBIUM STOCK CULTURES.

Growers throughout the Territory now commonly inoculate leguminous covers and shade trees with cultures of *Rhizobium*. Inoculum for the following legumes was supplied:

<i>Leucaena glauca</i>	..	..	..	..	..	3,670 bottles
<i>Pueraria phaseoloides</i>	..	..	..	..	..	7 bottles
<i>Glycine max</i>	..	..	..	..	..	6 bottles
<i>Centrosema pubescens</i>	..	..	..	..	..	15 bottles
<i>Phaseolus lathyroides</i>	..	..	..	..	..	3 bottles
<i>Medicago sativa</i>	..	..	..	..	..	2 bottles
<i>Trifolium</i> sp.	..	..	..	..	..	2 bottles
<i>Lotononis bainesii</i>	..	..	..	..	..	1 bottle
<i>Desmodium uncinatum</i>	..	..	..	..	..	1 bottle
<i>Lupinus</i> sp.	..	..	..	..	..	1 bottle

Inoculum was distributed to all parts of Papua and New Guinea and to Netherlands New Guinea. Record sheets were sent to selected places in the Territory for recording differences in height, colour and nodulation of inoculated plants in comparison with uninoculated plants which each grower was asked to sow at the same time.



Plate 17—*The best strains of Rhizobium promote growth of Leucaena glauca as efficiently as the application of nitrogenous fertilizers.*

[Photo : M. Trinick.]



Plate 18—*Leucaena glauca produces large, healthy nodules in sand culture when inoculated with an effective strain of Rhizobium.*

[Photo : M. Trinick.]

EFFICIENCY OF STOCK CULTURES MAINTAINED AT PORT MORESBY.

All stock cultures supplied by the Department were regularly checked for efficiency and ability to cause nodulation on their hosts. Biochemical characteristics such as growth on glucose peptone and potato plates, and Gram reaction and morphological characteristics, including motility, were regularly checked. Cultures for the following legumes were tested in the laboratory and glasshouse: *Albizia stipulata*, *Arachis hypogaea*, *Centrosema pubescens*, *Crotalaria anagyroides*, *Glycine max*, *Leucaena glauca*, *Phaseolus lathyroides*, *Phaseolus mungo*, *Phaseolus vulgaris*, *Trifolium pratense*, and *Vigna sinensis*.

Some of these cultures, especially for *Centrosema pubescens*, appeared to be sensitive to normal storage on agar slants in the refrigerator. A period of three months storage proved lethal for all the locally-isolated strains of *Rhizobium* from *C. pubescens* while strains from other hosts were unaffected.

The ability of cultures to inoculate their hosts efficiently has been satisfactorily tested using specimen tubes 10 in. x 2 in. filled with a nutrient agar, the plants growing through a narrow opening in the plug. Most of the legumes with fairly large seeds grew well in these tubes. The larger seeded legumes (e.g. *Canavalia* sp.) were tested in a modification (Dr. Morris) of the bottle-jar assembly first developed by Leonard of the United States Department of Agriculture. Small seeded legumes were tested under sterile conditions in specimen tubes containing vermiculite plus nutrient solution, but despite excellent growth of the plants, the nodules produced were very small. Agar cultures were much more satisfactory. The degree of effective nodulation was determined by the size and number of nodules produced, correlated with the dry weights of the plants. The relative efficiency of different *Rhizobium* strains on *Leucaena glauca* is illustrated in Plate 17, while Plate 18 shows the type of nodules produced on this host under favourable conditions.

Leucaena glauca field trials were set up at Sogeri in the Central District and Oriomo in the Western District. Many planters returned record sheets comparing the growth of inoculated with uninoculated plants. A Madang planter recorded a height of 15 feet for inoculated *Leucaena* compared with 9 feet for uninoculated plants after nine months' growth.

Other *Rhizobium* cultures are being tested in the field on the following legumes: *Centrosema pubescens*, *Desmodium intortum*, *D. uncinatum*, *Glycine javanica*, *Lotononis bainesii*, *Phaseolus atropurpureus*, *Pueraria phaseoloides* and *Vigna sinensis*.

RHIZOBIUM ISOLATIONS.

Isolations were made from the following hosts: *Albizia stipulata*, *Arachis hypogaea*, *Canavalia gladiata*, *Centrosema pubescens*, *Clitoria ternatea*, *Crotalaria anagyroides*, *Dolichos lab-lab*, *Glycine javanica*, *Glycine max*, *Indigofera arrecta*, *Leucaena glauca*, *Phaseolus lathyroides*, *Phaseolus lunatus*, *Phaseolus mungo*, *Pueraria phaseoloides*, and *Vigna sinensis*.

Many of the isolates from these legumes are being tested on their respective hosts.

NODULATION STUDIES.

Sogeri Soil. With *Centrosema pubescens*, *Pueraria phaseoloides* and *Arachis hypogaea*, nodulation increased with the addition of P, K, and trace elements while the addition of N tended to reduce nodulation. The rhizobia responsible for nodulation survived in the soil which had a pH of 4.5. With *Arachis hypogaea* the addition of calcium improved growth and nodulation.

Preliminary experiments with *Leucaena glauca* suggested that calcium was required for nodulation and that nodulation was not restricted by a pH of 5.0.

Brown River Soil. Variation in nodulation was recorded on a soil from the Brown River. The observations are summarized below:

No Nodulation	.. <i>Leucaena glauca</i> , <i>Acacia farnesiana</i> , <i>Phaseolus vulgaris</i> , <i>Caesalpinia</i> sp.
Poor Nodulation	.. <i>Glycine max</i> .
Fair Nodulation	.. <i>Crotalaria anagyroides</i> , <i>Centrosema pubescens</i> , <i>Dolichos</i> <i>lab-lab</i> , <i>Pueraria phaseoloides</i> , <i>Clitoria ternatea</i> , <i>Glycine</i> <i>javanica</i> .
Good Nodulation	.. <i>Flemingia congesta</i> , <i>Vigna sinensis</i> .

OTHER STUDIES.

Germination of many of the tropical leguminous seeds is difficult unless they are pretreated before sowing. Hot water treatment is the easiest to apply, but the best results with *Leucaena glauca* have been obtained by using concentrated sulphuric acid. *Leucaena glauca* pretreated with hot water has been shown to maintain its viability for over a month after treatment. The following seeds produced locally germinated well without pretreatment: *Albizia stipulata*, *Pueraria phaseoloides*, and *Cajanus cajan*.

Hypertrophies on *Centrosema pubescens* were reported by Bowen, 1959 (Specificity and Nitrogen Fixation in the *Rhizobium* Symbiosis of *Centrosema pubescens* Benth. *Queensland J. agric. Sci.* **16**: 267-281). Similar conditions have been observed on other tropical legumes growing in New Guinea.

VIROLOGY.

Some of the virus conditions which have been investigated at Keravat are listed below.

CHLOROTIC SPOT OF *PASSIFLORA FOETIDA*.

A full report on the investigations carried out on this virus disease will shortly be published in the following paper: R. J. van Velsen: "Chlorotic spot, a virus disease of *Passiflora foetida* in New Guinea". *Papua and New Guinea agric. J.* (In press.)

The summary of the paper is as follows:

Studies on the symptomatology, identity and transmission of passion fruit chlorotic spot virus, a hitherto undescribed virus, are recorded. The virus can be mechanically transmitted to *Passiflora foetida* L., *P. quadrangularis* L., *P. edulis* Sims. var. *flavicarpa*, *P. alba* Link and Otto., *Crotalaria anagyroides* H.B. and K., and *Nicotiana sylvestris* Spegazzini and Comes, but not to *Passiflora edulis* Sims., nor to *P. suberosa* L.

The thermal inactivation point of the virus lies between 60 and 65 degrees C. for an exposure of 10 minutes; the dilution end point lies between 10^{-6} and 10^{-7} and longevity *in vitro* is between 48 and 72 hours at a room temperature of 28 degrees C.

The virus is transmitted in the laboratory by wingless adults of *Aphis gossypii* Glover in a non-persistent manner, and occurs naturally in the field on *Passiflora foetida*, *P. quadrangularis*, and *P. edulis* var. *flavicarpa*.

CHLOROSIS OF SCHWARZ 21 PEANUT.

The work on this virus disease was concluded and the report is awaiting publication in the *Papua and New Guinea Agricultural Journal*. The paper will be entitled "Marginal chlorosis, a seed-borne virus of *Arachis hypogaea* variety "Schwarz 21" in New Guinea" by R. J. van Velsen.

The summary of the paper is as follows:

Observations on the symptoms, effect on yield, and experimental data are given on a seed-borne virus disease of *Arachis hypogaea* variety "Schwarz 21" in New Guinea. Attempts at mechanical, soil and insect transmission were unsuccessful, but the virus was transmitted through cleft grafts from Schwarz 21 to Red Spanish, White Spanish, Schwarz 21, Virginia Bunch and Natal Common. The virus causes a severe stunting of the affected plants, with marginal chlorosis and crinkle of the leaves.

The yield of affected plants is reduced to half that of healthy plants. Control is readily effected by vigorous roguing at the flowering stage of all affected plants. The virus appears to be a new one previously undescribed and is tentatively named peanut marginal chlorosis.

MOSAIC OF CENTROSEMA AND OTHER LEGUMES.

Investigations on this virus disease were concluded and some results published in conjunction with Dr. N. C. Crowley of the Waite Agricultural Research Institute, Adelaide, in the following paper: R. J. van Velsen and N. C. Crowley: "*Centrosema* mosaic, a plant virus transmitted by both aphids and plant bugs". *Nature*, **189**: 858 (1961).

CASSIA MOSAIC VIRUS.

This work has been concluded and the report is likewise awaiting publication in the *Papua and New Guinea Agricultural Journal*.

The title of the paper will be "*Cassia* mosaic, a plant virus of *Cassia* spp. in New Guinea" by R. J. van Velsen.

The summary is as follows:

Experimental data are recorded on the host range and physical properties of cassia mosaic, a previously undescribed virus disease of *Cassia occidentalis* L. in New Guinea. The virus is readily transmissible to *Cassia occidentalis*, *C. tora* L. and *Crotalaria anagyroides* H.B. and K. The dilution end point lies between 1:1,000 and 1:2,000, thermal inactivation point between 60 and 62 degrees C. for an exposure of ten minutes and longevity *in vitro* less than 168 hours. To date no insect vector has been located and the virus is not seed transmitted in *Cassia occidentalis* nor *C. tora*.

LITTLE LEAF OF ACALYPHA.

The work on this virus disease has been concluded and is also awaiting publication.

TARO ABNORMALITIES.

The following taro abnormalities were investigated and found to be either genetical or physiological.

Galls on petioles.

Leaf crinkle.

Leaf blotch.

Petiole striations, green and cream.

Petiole striations, green and purple.

Stunting.

SWEET POTATO ABNORMALITIES.

Little progress was made in the study of the conditions listed in the 1959-60 annual report except laminar variegation, which proved to be a genetical condition. No insect vectors were established for the other two abnormalities. Further possible vectors are being studied and grafting is being attempted.

HIPPEASTRUM STREAK.

All solanaceous hosts tested proved to be resistant to this virus, but it was readily transmitted to *Hippeastrum*. Tests are in progress to determine its physical properties; no vectors have yet been located.

COWPEA MOSAIC VIRUS.

Investigations were concluded on this virus in respect to host range and physical properties, and the search for vectors continued.

AIBIKA MOSAIC VIRUS.

Host range and physical property tests are in progress on this virus disease, but difficulty is being experienced in obtaining consistent results.

CACAO MOTTLE.

Studies of a mottle on cacao suggested that a virus was not involved.

LITTLE LEAF OF LEUCAENA GLAUCA.

Rooted cuttings of *L. glauca* showing a "little leaf" condition were received from Popondetta and Kokopo, but when grown in sterilized forest soil, all produced healthy, vigorous shoots. It was concluded that a virus was not involved.

WITCHES BROOM OF CAJANUS CAJAN.

Thirty-three plants in the food garden at Keravat showed a severe witches broom condition on young secondary shoots. These shoots were infested with numerous colonies of mealy bugs. Tests are being carried out to determine whether a virus disease is involved.

MISCELLANEOUS INVESTIGATIONS.

VIRUS SURVEYS.

Two virus surveys were made, the first in October, 1960, to Manus, Wewak and Madang, the second in May/June, 1961, to Rossell, Misima, Trobriands, Goodenough, Wedau and Samarai. Mycological material was also collected during the second survey.

FIELD LOSSES DUE TO *Phytophthora palmivora* ON CACAO.

The following observation trials to determine field losses were commenced in November, 1960:

- (a) Observations on mother trees K5, K6, K20, K15-101, K23-102, K23-104 and K27-102 to determine field losses due to black pod. Counts were made at irregular intervals.
- (b) Observations on clonal trees of K5, KT82, K52 and K50 to determine losses amongst the four clones and losses on individual trees within each clone. Counts at three-weekly intervals.
- (c) Observations on seedling trees from mother trees K19, K13, K26, K16, K20, K21, K25 and K23. Counts at two-weekly intervals.

FIELD COLLECTION OF APHIDS.

Collection of aphids from Mohricke yellow trays in the food crop garden at Keravat were commenced on 22nd July, 1960, to observe population variation and seasonal variation in the field.

DISEASE IDENTIFICATION SURVEYS.

Limited plant disease identification services were maintained throughout the year for the planting community in the New Britain District.

GENERAL PATHOLOGY.

During the year, 440 accessions were handled at the Moresby laboratory. These specimens were received from the general public or Agricultural Officers or were collected in the field during surveys and investigations.

Specimens in good condition were lodged at the Port Moresby herbarium. Portions of many of the collection were forwarded to the Commonwealth Mycological Institute, Kew, England, for lodging, confirmation or identification. Specimens and/or cultures, slides and photographs were also forwarded to other specialists overseas.

Many of the records were new for the Territory and some are apparently new species and a few are new genera. These will be described by the Pathologist at Port Moresby or by overseas specialists.

The main cultural work carried out during the year was the isolation of organisms from the various accessions for identification and study. Services also included advice to and interviews with the public, commercial representatives and officers of the Department, relating to disease problems and aspects of quarantine.

CHECK LIST OF TERRITORY DISEASES.

The compilation of the Check List was continued during the year, and terminated at 30th June, 1960. The List will include diseases recorded during the previous six years, together with all previously published records. Future additions to the Check List will be published annually or whenever they occur, whichever is more appropriate.

INVESTIGATIONS AND SURVEYS.

BLACK CROSS DISEASE OF BANANAS.

A preliminary note on a new disease of bananas called "Black Cross", was published by C. Booth in *Commonwealth Phytopathological News*, 7(2) : 23, 1960.

The main paper describing this new disease caused by *Phyllachora musicola* sp. nov. was published by C. Booth and Dorothy E. Shaw in the *Papua and New Guinea agric. J.* 13(4): March, 1961.

The known distribution of this disease is now American Samoa, Fiji, Netherlands New Guinea, New Guinea (including the large islands of Bougainville and New Britain), New Caledonia, New Hebrides, and Papua.

FIELD INVESTIGATION AT FINSCHHAFEN.

In July, 1960, an investigation on coconuts was carried out at Finschhafen. The yellowing of the leaves and other symptoms observed could not be attributed to any known fungal disease. The condition is being kept under observation.

SURVEY AT ORIOMO RIVER.

In August, 1960, a survey was carried out at Daru, village gardens along the Oriomo River, and at the Agricultural Station on the Oriomo.

INVESTIGATION INTO ROOT ROT OF HOOP PINE, BULOLO.

In March, investigations were carried out on Root Rot of Hoop Pine (*Araucaria cunninghamii*) at Bulolo. Diseased trees in various stages were examined and fruiting bodies were collected from old stumps, and occasionally from just-dead trees, of both pine and forest species. The identification of the fruiting bodies as *Fomes noxious* was made at the Royal Botanic Gardens, Kew. The condition was distinct from the termite attack also observed. The multiple tips present on some trees were also examined and were considered not to be diseased.

GAZELLE PENINSULA AND TALASEA.

In April, native food gardens in the Warangoi Valley were checked for taro and sweet potato diseases. Native gardens were checked at Talasea for diseases of taro and other plants. Cacao plantations on the Willaumez Peninsula were examined for diseases.

MOUNT HAGEN AND BANZ.

Increased *Cercospora* spot through overexposure occurred both on coffee berries and on leaves on one property visited.

KAINANTU SUB-DISTRICT AND OKAPA.

Coffee plantations in the sub-district and native coffee gardens were checked for the presence of Pink disease and other diseases. Pink disease was found at one plantation and on one coffee bush at the Highlands Agricultural Experiment Station, Aiyura.

ECONOMIC ENTOMOLOGY.

The work of the Entomology Section was an extension of the projects initiated in previous years. However, increased attention was paid to such relatively new pests of cacao as the defoliating caterpillars and *Amblypelta*. An important observation was the occurrence for the first time outside Australia of the giant termite (*Mastotermes darwiniensis*) in Lae.

VISITING SPECIALISTS.

A number of overseas visitors came to the Territory during the year. Mr. R. W. Paine passed through briefly in January on his way back from investigating parasites of *Graeffia* and *Nacoleia* in the Solomons. The annual visit of the Queensland University geneticists was made by Mr. D. Angus during January and February to collect *Drosophila* in various parts of the Territory.

Dr. C. P. Hoyt, Technical Officer (Plants and Diseases) of the South Pacific Commission, visited the Territory during February for general discussions at Port Moresby and Keravat on the *Oryctes* project, prior to departing for East Africa for extended investigations on the biological control of this beetle.

Mr. B. A. O'Connor, Senior Entomologist, Department of Agriculture, Fiji, came to the Territory in May in connexion with a Plant Quarantine survey he was carrying out for the South Pacific Commission. He also discussed Pacific entomological problems at Port Moresby and Keravat.

Dr. J. L. Gressitt of the Bishop Museum, Honolulu, spent May and June on a general collecting tour of a variety of localities on the mainland. He also organized the establishment of the Bishop Museum Field Station at Wau; this was opened in June and will concentrate mainly on the bionomical aspects of the insects of the Territory.

IDENTIFICATIONS BY OVERSEAS SPECIALISTS.

The numbers of specimens sent overseas last year declined. However, the list of specialists willing to work promptly on Territory material has steadily increased and useful results have been received from many of the sources. Progress will be greater as more and more of the Bishop Museum Material is worked on.

CARD REGISTERS OF INSECTS AND COLLECTION.

There was a considerable addition to the general insect register by the incorporation of data from the British Museum going back to 1932. It was necessary to limit Head-quarters accessions owing to staff shortage and the cramped conditions in the laboratory prior to the move to the present quarters. For this reason, collections were largely confined to specimens of some economic importance.

Some additional metal storage cabinets were acquired at Head-quarters and at Keravat and these greatly facilitated the formation of a basic reference collection—particularly of pest species—at both centres. The question of the preservation of insects at Keravat appears to have been solved by the application of bottom heat to the trays; in fact, the mould problem no longer exists.

During his absence on leave, Dr. Szent-Ivany compiled a bibliography of New Guinea insects running into 1700 titles.

EXTENSION.

Entomological exhibits were placed in all the Agricultural Shows held in the Territory. There was some decline in the amount of interest shown in the exhibits at most Shows.

Progress was made at Keravat with the production of photographs of the principal insect pests of cacao and coconuts and of the damage caused by them. Wherever possible duplicates were made and distributed to agricultural officers. Mounted specimens of some of the insects were also distributed.

FIELD TRIPS AND SURVEYS.

These were somewhat less comprehensive than during the previous year owing largely to the imbalance of staff. However, the Western District of Papua was visited twice for the first time although nothing of special interest came to light.

Different members of the staff visited Popondetta as a result of the increasing entomological problems there.

The Highlands Districts were visited on a number of occasions but, generally speaking, the pests observed appeared to be of strictly localized importance except for the serious outbreak of *Prodenia litura* at Wau.

Visits were made to Manus and Madang to check the incidence of "Sexava", and to several Bougainville plantations, mainly in connexion with *Amblypelta*. Plantations at Talasea were inspected in order to gain an appreciation of their cacao borer problems. Rubber plantations in the Sogeri area and cacao plantations throughout the Gazelle Peninsula were visited as often as possible.

PESTS OF ECONOMIC CROPS.

COCONUTS.

COCONUT DYNASTIDS.

There was no report or observation of any new outbreak of *Oryctes*. Its distribution on New Ireland appeared to be remaining virtually static. It is thought that damage caused by *Scapanes* was wrongly ascribed to *Oryctes* in some areas. In parts of the Gazelle Peninsula, there was some increase in the incidence of *Oryctes*, especially in the vicinity of Rabaul. The added attack may have been caused by the coconut eradication campaign around the wharf area of the town. Although the beetle is spreading along the Baining coast, it is still of secondary importance to *Scapanes* and *Rhyncophorus*.

Biological Control.

Scolia ruficornis is still present in the vicinity of sawmills at Rabaul and Kokopo. At certain times of the year, the numbers of wasps on the wing is quite small, but towards the end of the dry season they become rather abundant. Several suspected sightings were made



Plate 19—Typical damage on a young coconut caused by *Brontispa longissima*. [Photo : L. Smee.]

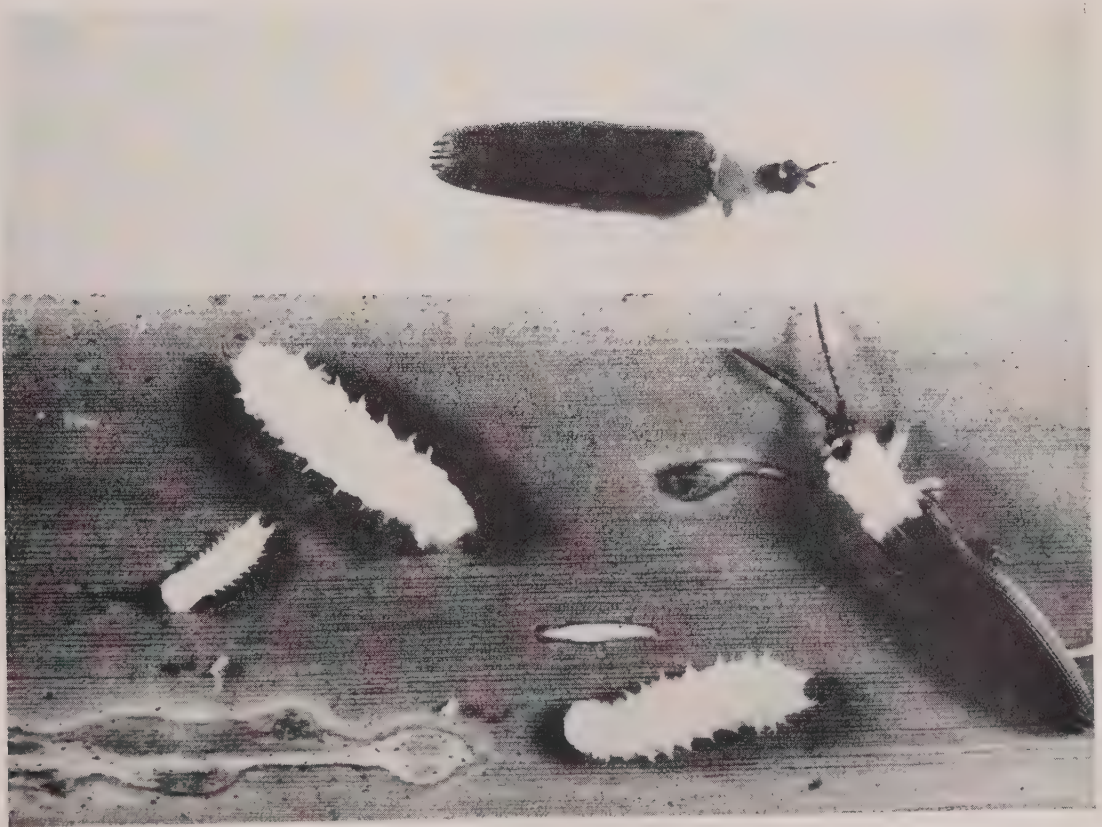


Plate 20—Adults and larvae of *Brontispa longissima* (X8). [Photo : L. Smee.]

in other parts of the Peninsula but these can only be taken tentatively as evidence of establishment. Owing to the difficulty of collecting an adequate supply of pupae or adult females locally, further attempts were made to obtain more pupae from the Carolines and adults from Zanzibar, for liberation in the Bainings and along the east coast of New Ireland. However, these liberations were uniformly unsuccessful. An unconfirmed report states that the pupae received from the Carolines have become established at Baia Plantation.

The scaritids from Nigeria (*Neochryopus savagei*) failed to oviposit in captivity although they mated and fed very readily. Accordingly, those that survived were liberated in the oil palm block on the station, together with others received from Nigeria. Light-trapping and search of palm stumps was carried out some eight months after they had been liberated but no evidence of their establishment was found. This may have been too short a time as they probably have a rather long larval stage.

The histerid *Pachylister chinensis* from Fiji was occasionally found in rotting palm stumps but showed little signs of reaching a useful population level. It almost certainly prefers animal manure for oviposition. The West Indian predators, *Leionota* and *Pyrophorus*, have still not been recovered.

The large native scoliid *Triscolia saussurei* was observed in some numbers in various parts of the Morobe District and on the Gazelle Peninsula. Attempts to persuade it to breed in captivity and thereby establish the identity of its natural host were again unsuccessful. It is possible that the size of the cages used was not suitable. When adult females are again abundant, it is proposed to attempt to breed them in larger cages and individual containers.

The predatory dynastid *Oryctoderus cononatus* was not encountered in any numbers during the year so that no progress was made in the study of the bionomics of the species. Evidence of predator action against white grubs was noticed from time to time but never on a scale that would indicate that it was significant.

Chemical Control.

The eradication of the palms in the vicinity of the wharf area resulted in an increase in the activity of the beetle in the immediate surroundings. However, this should eventually be balanced by an increase in the numbers of scoliids.

The three-monthly dusting of young palms in Block 402 at Keravat with DDT and BHC has been replaced with a similar dusting using Diazinon. The cost of the latter treatment would be too high from a plantation viewpoint. However, as it has been found to be considerably superior to DDT and BHC in Fiji, it is proposed to use it here—and even to reduce the intervals between dustings if necessary—in order that the block may be brought into reasonable bearing. The Diazinon is applied in the form of sawdust sprayed to wetness with an 0.5 per cent. solution and then sundried and packed in the frond axils as required. The study of the effect of the treatment in the field was discontinued as extraction of the beetles for examination was causing more damage than the insect itself. However, tests in the insectary showed that the treated sawdust remained lethal to both *Oryctes* and *Rhyncophorus* for approximately six to eight weeks, the time taken to kill the beetles becoming longer as the sawdust aged. The damage to the palms in this block was still severe but few failed to survive.

The new Coconut Trial block on the Vunapau road progressed well and, so far, has shown only slight peripheral damage from *Scapanes*. It is possible that this block will remain free of *Oryctes* for some years.

At Bubia, the control of *Scapanes australis* by the use of BHC is proving successful.

PALM WEEVIL.

The palm weevil (*Rhyncophorus* sp.) continued to cause insidious loss of young palms throughout the Territory. A series of experiments to control the insect by the application of various insecticides (pyrethrum, dipterex, dieldrin, &c.) to an auger hole at the site of observed larval activity proved to be ineffective. The treatment of individual palms with dieldrin is still the only method advocated for the control of this species.

Beyond the finding of predators of the weevil at Anir Island, no progress was made with inquiries into the biological control of this species.

SEXAVA.

Although this group has been reclassified into a number of species of the genera *Eumossula* and *Segestidea*, the retention of the term "Sexava" seems desirable on account of its well-established usage. The occurrence of the pest during the year was quite pronounced on parts of New Ireland and several islands to the east, and also on Manus and several groups

of islands to the westward (Western Islands, Wuvulu, &c.). In response to numerous requests, continuous series of "Sexava" eggs parasitized by *Leefmansia* were despatched to the affected areas. Despite the relatively long time taken to reach such places as the Western Islands emergence of parasites appears to have been satisfactory and a report of recoveries of the wasp was received from Wuvulu several months after the parasitized eggs were received.

The work on the strepsipteron parasite of "Sexava" that has been going on at Bubia for some time has made no further progress. It has still not been possible to discover the male or its host. The tachinid parasite first found by O'Connor near Madang appears to offer little scope for use as a biological controlling agent in the Bismarck Archipelago. Although the adults have not yet been bred out, eggs have been found attached to "Sexava" adults and traces of larval activity have been found in the bodies of specimens dissected during the work on *Stichotrema*. It would appear that the parasite is quite small and that the grasshopper is capable of rearing a number of flies without ill-effect.

No response was received to an offer to exchange *Leefmansia* for *Scolia ruficornis* pupae with the Carolines where *Segestidea* is reported to cause severe damage.

COCONUT LEAFMINER.

Occasional localized damage to young palms was noticed in the vicinity of Keravat. The position at Lindenhafen Plantation remained satisfactory with very little trace of the insect. At Linga Linga Plantation recovery has been much slower and production was still below normal. An examination of several plantings at Talasea showed *Promecotheca* numbers at a very meagre level. An investigation of the parasite complex of *P. cumingi* in British North Borneo may be worth considering at a later date.

BRONTISPA.

B. longissima was still widespread, although only moderately serious, in a number of areas, especially in nurseries and young plantings. Spraying with dieldrin is considered an economical proposition to enable the young palms to get away to a good start. A damaged palm is illustrated in Plate 19, and Plate 20 shows the causal insect.

AMBLYPELTA.

Nutfall of coconuts is now known to be widespread in Papua as a result of the activities, of *Amblypelta*. The Papuan species (*Amblypelta lutescens*) is also responsible for considerable loss of production in the D'Entrecasteaux Group and other islands to the east. The species causing nutfall at Numa Numa Plantation on Bougainville has been confirmed as the Solomon Islands species—*A. cocophaga cocophaga*. Precisely why the insect is confined to such a circumscribed area on Bougainville is far from clear. At Numa Numa, a suggested programme for the control of the ant *Anoplolepis longipes* is in operation and is said to be quite effective. The fact that *Amblypelta* is taking readily to cacao, where it can be reasonably simply controlled, suggests that the use of interplanted cacao as a catch crop may be a feasible way to control nutfall in coconuts.

AXIAGASTUS.

The flower bug, *Axiagastus campbelli*, is commencing to receive attention from outside sources as a prime factor causing nutfall of coconuts. This is said to occur on Bougainville, New Ireland and on the islands to the east of the latter. That this should be so is difficult to credit, as in the past the flower bug has been completely absolved by a number of entomologists who have carried out detailed work on the nutfall problem. They have observed that the insect, which does not cause a necrotic scar after feeding like *Amblypelta*, attacks the male flowers first, the stalk of the inflorescence second and only then does it move to the female flowers. It is possible that a very dense population could cause some degree of nutfall but cage trials using as many as 150 nymphs and adults on a recently opened spathe showed that it held virtually the same number of nuts as a nearby spathe without any *Axiagastus*. It is of interest to note that complete nutfall has been produced at Keravat by the caging of spathes before they opened. In this case, which may be exceptional, the fall was due to the fact that eggs of *Tirathaba* and an undetermined species of moth were laid on the spathe sheath and entered the inflorescence before it opened. The caging effectively prevented the entry of the usual predators and the majority of the eggs were able to hatch and develop without the normal hazards.

While the desirability of settling the question of the relationship between *Axiagastus* and nutfall is apparent, it is difficult to do any detailed work on the problem as the insect is extremely scarce on the Gazelle Peninsula. The possibility that the local scarcity of the insect is due to

the action of parasites or predators has been considered but there are so few *Axiagastus* present that an adequate source of material to work with has not yet been found.

MISCELLANEOUS PESTS.

A number of pests of a minor nature recorded during the year were of strictly localized importance and the duration of their effect was usually ephemeral. Probably the most important were *Cephenes* and *Tirathaba*. Various Hemiptera observed in passing were all effectively controlled by parasites or predators.

CACAO.

CACAO WEEVILS.

The different species of *Pantorhytes* in various parts of the Territory continued to have their cumulative adverse effect on cacao trees as more and more reached the age at which they become acceptable hosts. This was especially so at Popondetta and on the Gazelle Peninsula. In the former area, the native host, *Pipturus*, is being attacked by *P. szentivanyi* extensively, which will, no doubt, cause considerable trouble in a few years' time.

The spraying experiments to attempt to devise reasonable control measures for *P. plutus* were continued at Keravat. It is becoming apparent that a successful outcome to this trial is questionable. However, it is intended to carry out several more series of sprayings and then refer the problem for statistical analysis and advice. With the current net return for cacao per acre, it seems that a regular spraying programme for timber-boring insects would not be an economical proposition. The only economically practicable spraying programmes would be for the protection of the fruit (against capsids, pod borers, &c.) and the protection of the flush of young trees (against defoliating caterpillars, eumolpids, &c.) to ensure that they get a good start in life.

Examination of the borer position at Talasea was of interest. Weevils and longicorns were both virtually absent at Walindi and Volopai Plantations while Lagenda was supporting the densest population of the greatest number of species yet encountered in the Territory, including a species of *Pantorhytes* not previously recorded from cacao. There was no apparent reason why this should have been so.

Experiments with weevil control at Bubia were largely allowed to lapse during Mr. Ardley's absence on leave and his subsequent preoccupation with station routine after his return.

CACAO LONGICORNS.

Both *Glenea aluensis* and *G. lefebouri* continued to cause moderate damage to young cacao in the more northerly parts of the Territory. At Popondetta, while only of minor importance, *Tmesisternus* sp. appeared to be the dominant longicorn. Some loss of young trees up to eighteen months old was of general occurrence. However, on Bougainville, population densities were not infrequently sufficiently high to kill by ring-barking trees up to six years old.

Control of the larvae by the fumigating action of dieldrin applied to the bark above the borer channel is still recommended for these species. Additional trials will be carried out in due course in an effort to find an insecticide which will be equally effective against the weevil and the longicorn.

CACAO CAPSIDS.

The various species of capsids are responsible for considerable loss of cacao despite the fact that they are readily controllable by almost any insecticide, although endrin and BHC are still considered to be the best specific insecticides against them.

A report that capsids have been causing damage on a plantation on Buka Island has still to be confirmed.

Shoot damage has been seen from time to time but there is so far no indication that this type of damage is on the increase. It appears to be most prone to take place when the population level is particularly high and the canopy rather open.

Trials were continued to determine whether the use of BHC as lindane or gammexane was preferable. The results again were not conclusive. However, as there is practically no difference between the landed prices of the two, lindane is now recommended. In small trials, malathion misting was less effective than endrin and telodrin had no advantage over the latter, even at almost twice the dosage. Despite the high toxicity of endrin, its use is still recommended, as the rate of application per acre is so low that the likelihood of toxic hazards is practically non-existent.

AMBLYPETA.

As mentioned under coconuts, *Amblypelta* is capable of causing severe damage to cacao pods. On Bougainville, however, its distribution is so strictly limited that control should present little difficulty. At Popondetta, on the other hand, the distribution of *A. theobromae* is extensive and could present some problems in Native plantings. The effects of the feeding of this species is considerably more damaging to the pods than that of either *Pseudodoniella* or *Helopeltis*.

In New Britain, the local variety of *A. costalis* was extremely rare during the past year. Whether this was due to the suppressive effect of parasites is a problem which warrants investigation when a source of material can be found.

DEFOLIATING CATERPILLARS.

Various species of defoliating caterpillars began to show signs of an increase in activity, particularly in the Popondetta area, and to a lesser extent on the Gazelle Peninsula. In the latter area, the noctuid *Achaea janata* and the geometrids *Ectropis bhurmitra* and *Hyposidra talaca* were found; there were also several other species belonging to the families Lymantriidae, Psychidae and Limacodidae, but these have never been known to assume a position of economic importance. It is of interest to note that the three species mentioned above were last noted in abundance in 1948 when the first post-war cacao plantings were developing. From that time until this year their population level has been so low that specimens have frequently been difficult to collect.

At Popondetta, attack by the noctuid *Tiracola plagiata* commenced in the first half of the year and it would appear that the conditions provided for it there will permit it to do considerable damage before it returns to a natural equilibrium with its environment. It is to be noted that a widespread outbreak of defoliating caterpillars is occurring in British North Borneo at the present time under conditions rather similar to those obtaining at Popondetta and in New Britain. As most of the species causing the damage have a geographical range extending from South-east Asia to Northern Australia, it can be anticipated that any, or all, of them may eventually make their presence felt in the various cacao-growing areas of the Territory.

Other defoliating insects, apart from instances of minor damage by several species of eumolpids, were of no significance during the year. Damage caused by *Achaea janata* is illustrated in Plate 21.

MEALYBUGS, SCALE INSECTS AND APHIDS.

Scale insects and mealybugs have been recorded from all parts of the Territory as minor pests of cacao. The common mealybug *Planococcus citri* is illustrated, with its attendant ants, in Plate 22. There are many other less common species. Aphids are also relatively common, as are several species of scale insects, but none appears to cause appreciable damage.

BARK-CHEWING INSECTS.

The xyloxyctid *Panseptia teleturga* appeared to be causing most concern in the plantations of the Baining coast. On several places it was said that the attack involved almost all the branches of bearing trees. Experiments on the control of this species are still being hampered by the fact that the moth has not been found at Keravat and nearby plantations have been only lightly affected for some time past. It is of interest to note that the species has been recorded from Netherlands New Guinea.

There has been some increase in the incidence of the borer *Zeuzera* sp., but it cannot be considered a serious pest.

Two species of clear-winged moths (*Conopia* spp.) were noticed from time to time but they seemed to be significant only on already debilitated trees.

POD-BORING INSECTS.

The pod-boring moth *Olethrus* was not infrequently the cause of pod losses in New Britain and in parts of Bougainville. While no separate experiments were carried out on the control of this species, it was usually commonest during the wet season and often associated with capsids, so that normal control measures adopted against the latter would keep the former in check. Damage by this moth is often more apparent than real as the larva does not penetrate the rind of the pod. However, pod rotting will be quite extensive if the attack occurs during a protracted wet period.

Life-history observations were commenced on this species.



Plate 21—*Achaea janata* may cause severe defoliation of cacao.

[Photo : L. Smee.]



Plate 22—Mealybugs (*Planococcus citri*) on cacao, with attendant ants.

[Photo : L. Smee.]

CACAO TERMITES.

Neotermes sp. in New Ireland still appeared to be restricted to cacao in the vicinity of Lakuramau Plantation. Attempts to control this ground-entering termite have so far been unsuccessful.

Except in New Ireland and New Britain, damage by termites to cacao was not recorded as significant. In the Gazelle Peninsula, *Neotermes* was beginning to cause widespread damage, although entry via the root system (as in New Ireland) was still not commonly encountered. Local attack on *Leucaena* was increasing considerably, no doubt because of the amount of shade thinning being carried out.

It is considered that damage by termites is largely a matter of faulty plantation management. A close examination of the Keravat cacao and *Leucaena* during the year revealed that some 2,500 trees or stumps were attacked to a greater or less degree and in almost every case entry could be ascribed to the presence of *Leucaena* stumps or to faulty pruning of the cacao. However, control was easily effected by locating a downward-sloping gallery and introducing an 0.5 per cent. solution of dieldrin; the amount used varied with the size of the termitarium but even the largest one would not require more than 150 cc. of liquid.

COFFEE.

The general incidence of the main coffee pests in the Highlands was not severe and only in isolated instances was the application of control measures necessary. This lack of high populations was ascribed to adverse weather conditions and, in the case of the leafhopper and the cupmoth, to the high incidence of entomophagous fungi.

Studies in the bionomics of the coffee ring borer (*Meroleptus cinctor*) and the leafhopper (*Batrachomorphus* sp., earlier identified as *Selenocephalus*) were continued but host plant difficulties with the former and low populations of the latter made progress slow. Counts of the population numbers and fluctuations of both species were measured.

For the first time since the war, coffee scale and mealybugs were noticed at Keravat in numbers high enough to necessitate spraying. In all cases, the hemipterons were accompanied by the fire ant *Solenopsis* sp.

RUBBER.

The incidence of pests attacking this crop remained much the same as in the previous year. Severe damage was mainly confined to nurseries and recent plantings and the control recommendations proved effective.

Amblypelta continued to cause moderate damage from time to time in the Sogeri District. There was some increase in the numbers of the weevils *Idiopsis coerula* and *I. grisea*. *Tiracola* also caused periodic damage.

It was not possible to initiate negotiations for a trial of egg parasites of *Pseudotheraptus* against *Amblypelta*.

GIANT AFRICAN SNAIL.

No reports have been received to indicate that *Achatina* has reached any new part of the Territory during the past year. Continued outward spread on the Gazelle Peninsula caused considerable damage to plantings in the Warangoi area as the land was cleared and planted, and very high populations are moving steadily along the Baining coast.

At this stage, it appears safe to say that the Florida predatory snail (*Euglandina*) is unfitted to the climatic conditions obtaining in the Territory. The African predatory snail (*Gonaxis*) continued to multiply steadily although it is doubtful whether it could yet be claimed to have any controlling effect on *Achatina*.

Further collection of *Gonaxis* at Keravat and Kokopo was carried out during the year after periods of continued rain. The results of the collections were distributed to various parts of the Territory whence they had been requested. There were no reports of establishment of snails from the previous year's distribution, although it is understood that the material sent to Netherlands New Guinea is being successfully bred under insectary conditions.

During the year a number of batches of the predatory drilid beetles (*Selasius* spp.) was obtained from Nigeria. As the insects were obtained in small batches over a period of several months, direct field liberations were not practicable. Accordingly, considerable effort was expended in trying to breed them in captivity—at least to the stage where they laid eggs. This, however, was unsuccessful, since not only were the females more numerous than the males, but the few males that did emerge did so, except in one instance, at different times from the

females. As the latter commence ovipositing in captivity within 48 hours of emergence if they are not fertilized, the net result was only a few dozen fertile eggs although some 25,000 were laid altogether. The eggs that eventually hatched were insufficient to form the basis of a laboratory breeding stock.

From this brief experience, it would appear that this species shows considerable promise as a biological controlling agent for the Giant snail. It is very aggressive and has a reproductive potential of the order of 500 eggs per female. Further efforts will be made to obtain additional supplies next wet season.

As far as the chemical control of the Giant snail in gardens and young cacao is concerned, use is still being made of metaldehyde-Flintkote-detergent bands for protecting individual seedlings. However, the bands are being widely replaced by the incorporation of metaldehyde with cement and sawdust to make a thin layer of substrate which is then shattered and broadcast. This is simply made and is simpler to distribute.

SPRAYING AND DUSTING MACHINERY.

The use of motorized one-man units is becoming increasingly widespread through the Territory as appreciation of the extent of losses by pests and diseases is being realized.

At Keravat, attempts to use the Micron and Micronette have been discontinued. The machines in use there (Fontan and Motoblo) continued to give reliable service. Generally speaking the latter developed fewer running troubles than the former and gave better coverage where treatment of older cacao and *Leucaena* was necessary.

Other makes of machines received on loan from their importers for trial at Keravat included Fontan (direct and belt drive), Marino "Blowamist", Limbert "Limblo" and Dorman Osprey "Ace".

TIMBER PESTS.

The increase in the damage caused by a termite (*Coptotermes* sp.) in the pine plantings at Bulolo and Wau caused Mr. Ardley to make several visits there to assess the extent of the damage and to lay down preliminary trials along the lines suggested by the Malayan Rubber Research Institute for the control of their species of *Coptotermes*. These trials are still in progress.

A potentially very important termite was located operating in the Lae township area towards the end of the year. This was *Mastotermes darwiniensis* and this is the first time it has been recorded outside Australia. In its own ecological niche it is considered to be the most destructive of all the termites and it is intended to devote considerable attention to it in the coming year.

FOOD CROPS.

Occasion for other than incidental observations on pests affecting Native food crops did not arise during the year. However, an extensive outbreak of the armyworm *Prodenia litura* occurred at Wau in European market gardens and caused severe losses. It would appear that the build-up was brought about by a number of factors including faulty management, inadequate application of insecticides, growth of volunteer plants and failure to remove crop residues after harvesting.

ORNAMENTAL TREES AND SHRUBS.

Periodic spraying of ornamental trees and shrubs was carried out at Keravat as required by the occurrence of a number of pest species, and a regular spraying of cacao and ornamentals was instituted in the nursery. It is of interest to note that there was a marked decline in the numbers of the nymphalid *Catopsilia* to a point where spraying was no longer necessary.

MISCELLANEOUS CROPS.

Only incidental observations during field trips were made on such crops as cotton, rice, maize, &c. However, some species of pests were bred out and recorded.

BIOLOGICAL CONTROL.

Apart from the introductions mentioned under coconut dynastids and *Achatina*, the only instance of a parasite introduction was the ichneumon *Horogenes* sp., introduced to Aiyura to control the cabbage moth (*Plutella maculipennis*). The wasp was recovered in the field several months later, although it was considerably out-numbered by a local *Brachymeria*.

AGRICULTURAL CHEMISTRY.

The work of the Chemical Section during the year 1960-61 was impeded by the resignation of Senior Chemist, Mr. S. C. Baseden, which resulted in the cessation of activities at the Keravat laboratories, and also by the absence of four members of the Head-quarters Chemical staff on recreation and long leave, which led to difficulty in maintaining services at the Konedobu laboratories. Moreover, whilst it was expected that the soils laboratory building at the Kila Quarantine Station would be completed and ready for occupation early in the year, delays in the provision of services did not permit occupation until the last week of the year.

Although there was a reduction in the number of samples examined, the number of single determinations was greater than in the previous year as a consequence of the nature of the analyses undertaken. As staff absences reduced opportunities for the collection of samples, greater emphasis was placed on providing chemical services to sections forwarding samples for analysis, as well as continuing the drive to overcome the back-log of unanalysed soil samples.

The comprehensive chemical investigations and field trials associated with the Markham Valley investigation were continued.

Foliar methods of diagnosis were expanded, and studies included investigations of the effects of position of the leaf on the plant and the effect of the age of tissues on nutrient composition, as well as a critical examination of chemical methods published overseas.

There was a marked reduction in the total number of soil samples received during the year, largely because of the delivery of a consignment of several hundred soil samples to the laboratory at the end of the previous year and shown as received at that date but not examined. The number of soil samples received from private sources increased sharply, owing to the activities of a recently formed firm of agricultural consultants.

A summary of the types of samples received and examined during the year is given in Table 53.

TABLE 53.—SAMPLES RECEIVED AND EXAMINED DURING THE YEAR 1960-61.

Type of Sample.	Received.	Examined.
Soils	803	1,190*
Coconut waters	10	10
Plant leaves	510	510
Produce	9	9
Fodders	7	7
Waters	29	29
Phytochemical	13	1
Miscellaneous	45	45
Total	1,426	1,801

* Includes samples from the previous year.

A more detailed description of investigations will now be given under the headings "Soil Analysis", "Plant Nutrition Studies" and "General and Industrial Investigations".

SOIL ANALYSIS.

Soil samples were received and examined as shown in Table 54.

TABLE 54.—SOIL SAMPLES RECEIVED AND EXAMINED, 1960-61.

Source of Sample.	Received.	Examined.
Konedobu Laboratory—		
Private sources	296	293
Soil Survey Section, D.A.S.F.	415	856*
Other D.A.S.F.	91	41
Other Government Departments	1	..
Total	803	1,190

* Includes samples from the previous year.

At the end of the year, 163 soil samples were currently outstanding, and of these, 141 were partially examined. Soil samples received from the Bougainville reconnaissance survey are not included although previously reported as partially analysed. Abnormally high soluble salt content in some of these samples suggested the possibility of contamination by sea water during transport in small ships and work was discontinued pending further investigations.

SOIL SURVEY SAMPLES.

WAHGI VALLEY SURVEY, WESTERN HIGHLANDS DISTRICT.

Analysis was completed on 522 samples collected from the andesitic ash beds and peaty clays of the Mount Hagen area. Owing to the high variability of these soils and the volume of determinations carried out, it is not possible to present a condensed description of their characteristics in a report of this nature. The investigation will be continued during the coming year and the interpretation of the analytical results will be the subject of a separate report.

BAIYER RIVER INSPECTION, WESTERN HIGHLANDS DISTRICT.

The analyses of eighteen samples received from the Baiyer River grasslands indicated that the soils were rich in organic matter and of high nitrogen status but poorly supplied with other major nutrients.

VUDAL SURVEY, NEW BRITAIN DISTRICT.

Analyses of 63 samples from the Vudal Agricultural College area indicated neutral soils of a high level of fertility consistent with the other pumice soils of the Gazelle Peninsula.

TALASEA SURVEY, NEW BRITAIN DISTRICT.

The analyses of 44 samples collected during a reconnaissance survey in the Talasea area were completed. The results indicated a high level of fertility in the pumice soils of the Bulu, Nalukoru and Wangu Wangu lands, but the soils of the Rikau land did not reach expectations, being of low exchange capacity and poorly supplied with potassium, magnesium and nitrogen. It was found that the soils of the Dagi River, Gigo and Waigaungo lands contained unexpectedly high percentages of exchangeable sodium accumulated throughout the profile. These soils were slightly acid in reaction, with soluble salt contents varying from low to levels which must be considered highly toxic.

OKAPA SURVEY, EASTERN HIGHLANDS DISTRICT.

The analytical results of the 78 soil samples collected from the Okapa region reflected the general pattern of highland soils, being strongly acid in reaction and of low phosphate availability. They varied from highly leached clays and peats, usually low in potassium, to base-saturated soils of moderate exchange capacity.

ARONA INSPECTION, EASTERN HIGHLANDS DISTRICT.

The analysis of seventeen samples collected at the Upper Ramu Livestock Station, Arona, revealed soils of moderate fertility. Whilst they were rich in organic carbon and of high nitrogen status, incubation tests indicated poor capacity to release nitrates. The analysis of thirteen samples collected in an adjacent area revealed soils with equivalent nutrient levels but a high capacity to release nitrates.

KABUNA SURVEY, CENTRAL DISTRICT.

Analysis of 33 samples indicated that, despite the presence of a heavy stand of primary forest, the levels of all major nutrients in the soils were very low and might not support an agricultural tree crop.

SOGERI SURVEY, CENTRAL DISTRICT.

A survey of land which might be utilized for re-settlement in the Sogeri District is in progress and analysis of samples is proceeding.

WAU INSPECTION, MOROBE DISTRICT.

The analysis of fifteen soil samples from a survey inspection in the Wau District indicated acid to slightly acid soils of moderate fertility.

OTHER DEPARTMENTAL SOIL SAMPLES.

GLASSHOUSE EXPERIMENTS.

Analyses were performed on 37 samples of soil utilized in the glasshouse experiments referred to in the "Plant Nutrition Studies" section of this report.

AGRICULTURAL EXTENSION DIVISION.

Analyses were completed on four soil samples and commenced on 50 samples received from the Division of Agricultural Extension. Of the latter group, 12 were collected from a Mission plantation in the Aitape region and 38 in the Telefomin area in connexion with a land utilization investigation.

PLANT NUTRITION STUDIES.

The plant samples analysed during the year are shown in Table 55.

TABLE 55.—PLANT NUTRITION SAMPLES ANALYSED, 1960-61.

Type of Sample.	Number analysed.
Coconut fronds	131
Cacao leaves	11
Coffee leaves (<i>Coffea canephora</i>)	1
Coffee leaves (<i>C. arabica</i>)	13
Tea leaves	15
<i>Pueraria</i> leaves	7
<i>Centrosema</i> leaves	14
<i>Leucaena</i> leaves	11
Peanut leaves	7
Sweet potato leaves	290
Citrus leaves	2
Rice leaves	8
Coconut waters	10
Total	520

Foliar analysis was further developed for use in the diagnosis of deficiencies and nutrient imbalances in Territory crops. Rapid methods of analysis were examined and analysis for the major elements nitrogen, potassium, phosphorus, calcium and magnesium was carried out on all samples with the aid of the latest flame photometric and colorimetric techniques.

Investigation has continued into the variation of methods of sampling used by overseas workers for tree crops, and tentative standard sampling methods for cacao, coffee, rubber, coconuts and various legumes have been adopted for use in this Territory.

Most of the plant samples were taken in conjunction with fertilizer trials and glasshouse pot tests. The more important projects undertaken were as follows:—

SWEET POTATO ANALYSES—SOIL EXHAUSTION TRIAL, KERA VAT.

The purpose of this trial was described in the 1959-60 Annual Report. Monthly sampling of sweet potato leaves from plots to which were applied varying rates of nitrogenous and potassic fertilizers was carried out in order to study the uptake of nutrients in the sweet potato tops.

A study was first made of the variation in chemical content between leaves from different positions on the vines and particularly of the influence of fertilizers on these contents. It was found that there was a greater variation in values for immature than for mature leaves, particularly for phosphorus and nitrogen. In addition, the phosphorus and potassium contents of the immature leaves were often twice as high as in mature leaves, necessitating modification in the analytical methods for these constituents. The method of sampling adopted was to bulk the first, second and third mature leaves on the vines, collecting 100 or more leaves from each plot.

The application of nitrogenous fertilizers increased the nitrogen contents of the leaves significantly but the effect diminished rapidly. There were large vine growth increases at the same time but heavy nitrogen applications caused a reduction in tuber yields. This was probably associated with an adverse nitrogen: potassium ratio, as leaf potassium levels had a tendency to decrease with high nitrogen levels and the average potassium content in the

leaves decreased as the trial proceeded. Information gained on leaf composition during this and other trials with sweet potatoes will be used as a diagnostic tool for the evaluation of soil fertility, as the crop is grown in all Territory areas.

SULPHUR DEFICIENCY IN TEA, GARAINA.

Tea leaves with the typical "Tea Yellows" condition ascribed to sulphur deficiency showed a lower total sulphur content than healthy leaves. Typical symptoms of moderate deficiency are shown in Plate 23. A small fertilizer trial laid down at Garaina produced marked growth responses to sulphur applications and alleviation of the deficiency condition. Healthy tea at Garaina is illustrated in Plate 24.

Soils and leaf samples taken from areas of the plantation affected by marginal chlorosis in the lower leaves showed fairly normal sulphur contents, while the calcium contents were extremely low.

Further comprehensive trials will be undertaken next year to estimate the fertilizer needs of the plantation.

COCONUT FERTILIZER AND THINNING EXPERIMENTS.

A large number of coconut leaf samples has been taken from current fertilizer and thinning experiments in New Ireland and at Baibara in Papua. These trials are referred to under the activities of the Lowlands Agricultural Experiment Station, Keravat.

On Katu and Lossu Plantations in New Ireland, the potassium content of fronds from potash-treated palms was consistently higher than from untreated palms and there was an associated growth response in the former.

At Baibara, average potassium figures were low enough to predict a probable response to potassic fertilizers. Various thinning rates of mature palms in conjunction with replanting significantly affected the uptake of nutrients in the young palms, as measured by the mineral content of leaves.

At present leaf sampling in coconut areas is restricted to the collection of leaflets from the youngest fully opened fronds. It is thought that results by this method may be greatly influenced by seasonal conditions and it is proposed to make a more thorough study of the variation in chemical content with frond position.

CHLOROSIS IN COCONUTS, FINSCHHAFEN.

The analysis of samples of coconut leaves, coconut waters and soils taken during a visit to the Finschhafen area showed that chlorosis in coconuts was associated with fairly low potash status throughout the area. The figures were very variable, however, and as the chlorosis was also associated in some cases with iron deficiency symptoms in cacao, native crops and ornamentals, the poor growth may have been partly due to lime-induced iron deficiency.

MARKHAM VALLEY CACAO INVESTIGATIONS.

Further nutritional investigations into the problem of cacao "die-back" in the Markham Valley were confined to fertilizer trials with the accent on minor element sprays. At the Bubia Plant Industry Centre and also at a neighbouring private plantation, cacao trees suffering from zinc deficiency or "sickle leaf" produced healthy flushes after spraying with zinc sulphate or a complete minor element spray. However, trees receiving complete fertilizer treatment still developed die-back. While trees in poor physiological condition could be more susceptible to a pathogenic disease, nutritional factors did not appear to be a primary cause of the die-back. Moreover, foliar analysis of affected trees showed that all major elements were in good supply.

GLASSHOUSE EXPERIMENTS.

An acid tropical red loam soil from the Sogeri District was comprehensively examined by means of pot tests in the laboratory glasshouse. Soil analysis showed low levels of nitrogen, phosphorus, potassium, calcium and magnesium. A large range of crops was grown to examine their comparative nutritional requirements and to produce typical deficiency symptoms. The tree crops coffee, cacao and rubber produced excellent deficiency syndromes for potassium and nitrogen when adequately supplied with all other essential nutrients, and leaf samples from these plants had suboptimal potassium and nitrogen contents. Although leaves from trees not receiving added phosphorus had low contents of this element, there was only slight diminution in growth. On the other hand, the legumes *Pueraria*, *Centrosema*, peanuts and



Plate 23—Sulphur deficiency of tea causes leaf distortion, yellow mottling, and, when severe, decline and eventual death.

[Photo : P. Southern.]



Plate 24—Young plucking tea at Garaina.

[Photo : D.I.E.S.]

Leucaena glauca were more sensitive to phosphorus deficiency, although potassium was probably more limiting. Tomatoes made no progress at all without added lime, whilst rice was sensitive to calcium, phosphorus and nitrogen deficiency.

GENERAL AND INDUSTRIAL INVESTIGATIONS.

AGRICULTURAL PRODUCTS.

PRODUCE.

Only 9 produce samples comprising 3 copra, 2 rice and 4 peanut samples were received during the year. They were examined chemically to assist in quality assessment.

PYRETHRUM.

Limited trials were initiated to determine whether the extracts from sun-dried flowers would give chemical assays and biological tests consistent with extracts obtained from oven-dried material. The results suggested that in areas where climatic conditions are favorable, sun-drying might be used without loss of biological effectiveness of the active constituents.

PASTURES AND FODDERS.

Several samples of the grass *Rottboellia exaltata* received from a farm on the outskirts of Port Moresby showed promising chemical attributes as a pasture species. The analytical results obtained are of interest and are shown in Table 56.

TABLE 56.—COMPOSITION OF *ROTTBOELLIA EXALTATA* AT DIFFERENT STAGES OF DEVELOPMENT.

Stage of Development.					Pre-flowering.	Flowering.	Post-flowering.
Approximate height	..	..	..	feet	2	6	7
Crude protein	..	..	..	per cent.	18.6	12.0	6.5
Fibre	..	..	..	per cent.	30.3	32.4	34.3
Ether extract	..	..	..	per cent.	4.2	3.0	1.5
Ash	..	..	..	per cent.	12.0	11.3	..
NFE	..	..	..	per cent.	34.9	41.3	..

It is intended that experimental plots of this grass will be established at the Moitaka Livestock Station so that a closer examination of its value may be made.

WATERS.

Twenty-nine water samples were received from a number of sources, including the Divisions of Fisheries and Animal Industry, the Commonwealth Department of Works, Department of the Army, Department of Civil Aviation and various private organizations.

PHYTOCHEMICAL INVESTIGATIONS.

MIMOSINE CONTENT OF *LEUCAENA GLAUCA*.

Forty-one samples, including the fruit and foliar material of *Leucaena glauca*, were received from Laloki, Korn Farm, Aiyura, Bubia and Keravat, and examined for their mimosine content. The foliar material came from local strains as well as three strains imported to the Territory with reputed low mimosine content.

The concentration of mimosine was found to be highest in the seed, but assays of the foliage were found to be quite variable and at times inconsistent. Young plants of the imported strains did not contain less mimosine than the local strains, either in lowland or highland environments. However, serious doubt has now been cast on the reliability of the method of analysis employed. (See "A Rapid Colouration Method for the Determination of Mimosine", *Univ. of Hawaii agric. Exp. Sta. Honolulu*, Tech. Paper No. 216; Hiroma Matsumoto and G. Donald Sherman.)

An investigation of chromatographic methods of analysis will be undertaken when special equipment for its application becomes available.

MISCELLANEOUS ANALYSES.

Miscellaneous samples analysed during the year are shown in Table 57.

TABLE 57.—MISCELLANEOUS SAMPLES RECEIVED AND EXAMINED.

Material.						Received and examined.	Purpose.
Imported tea	..	..	..	..	..	13	Quality assessment
Peanut oil	..	..	..	..	..	5	Quality assessment
Coconut oil	..	..	..	..	..	1	Quality assessment
Canned meat	..	..	..	..	..	4	Quality assessment
Tobacco trimmings	..	..	..	..	..	4	Nicotine content
Hair dye ..	..	..	..	..	..	2	Prohibited dyestuffs
Insecticides	..	..	..	..	..	1	Residual effectiveness
Rubber latex	..	..	..	..	..	2	Stability trials
Boiler scale	..	..	..	..	..	1	Identification
Miscellaneous chemicals	..	..	..	..	..	12	Identification (Coroner's inquest)
Total	..	..	..	..	..	45	

TOBACCO TRIMMINGS.

Samples of trimmings from highland tobacco were examined to assist consideration of the economics of nicotine sulphate extraction.

HAIR DYE.

Two samples of hair dye submitted by the Department of Public Health were found to contain the prohibited dyestuff p-phenylene diamine.

RUBBER LATEX.

Consequent upon the demand for samples of rubber latex for display purposes at agricultural shows in Australia, the Territory of Papua and New Guinea, and Netherlands New Guinea, re-agents were sought to prevent coagulation of the latex.

After investigation of chemicals used to delay coagulation in the field, a method was established which inhibited coagulation effectively for a period of several months. The additive recommended consisted of 0.5 per cent. Na_2CO_3 , 0.1 per cent. formaldehyde and 0.5 per cent. NaOH .

MISCELLANEOUS CHEMICALS.

Twelve samples were examined, representing Court exhibits collected from the site of a fire which destroyed an aircraft. The identification of several exhibits stated to have come from the seat of the fire enabled determination of the probable cause.

OVERSEAS VISITORS.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY (I.U.P.A.C.) PAPUA AND NEW GUINEA EXCURSION.

A party of 23 distinguished chemists was invited to visit the Territory after the I.U.P.A.C. International Symposium on the Chemistry of Natural Products which was convened in Australia. Professor Sir Alexander Todd, F.R.S., Nobel Laureate, led the party, which also included the Convenor of the Symposium, Dr. A. L. G. Rees. The Principal Chemist and the Chief, Division of Botany, Department of Forests, co-organizers of the tour, travelled with the guests during a six-day tour of the Highlands and several New Guinea centres, to inspect tropical rain-forest species of phytochemical interest.

Pyrethrum specialists, Dr. W. M. Mitchell and Mr. M. Watts, were invited to inspect highland centres and report on aspects of establishing a pyrethrum industry in the Territory. The Principal Chemist accompanied the visitors on a tour of possible production sites at Mount Hagen, Tambul, Kandep, Laiagam, Wabag and Goroka.

SOIL SURVEY.

Further substantial progress was made in the base survey of the Wahgi Valley, especially in the swamps west of the Tumen River.

A number of sub-divisional surveys was completed, mainly in the Cape Hoskins-Talasea area of New Britain. Much of this land was considered to be suitable for cacao and/or coconuts.

Reconnaissance surveys included 20,000 acres in the Baiyer Valley, surveyed as a potential tea-growing area, and 661 square miles near Okapa in the Southern Bismarck range, which was surveyed for its general agricultural potential.

More detailed reports are given below.

WESTERN HIGHLANDS DISTRICT.

The survey of ground control points for aerial photos of the Wahgi Valley-Mount Hagen region was completed and the data subsequently used in producing maps of the area.

Field work continued over an area of some 40,000 acres north and south of the Wahgi River, lying immediately west of the Tumen River. The soils were generally dark-coloured hydromorphics, mainly clays, with extensive areas of peats and mucks in drainage depressions.

CENTRAL DISTRICT.

A survey was made of resettlement areas for Papuans who will be displaced by lake waters from the proposed Sirinumu dam. The area comprised several blocks totalling 5,300 acres. The bulk of the land was steeply undulating with deep brown to bright red clay loams predominating. Less than 20 per cent. was suitable for garden cropping, although considerably more had potential for rubber planting. Erosion in gardened sites was described as a major hazard.

GULF DISTRICT.

A detailed survey of some 5,800 acres of land in the Murua River area was commenced as a preliminary to sub-division. The work will continue into 1961-62.

NEW BRITAIN DISTRICT.

VUDAL COLLEGE.

A detailed soil survey and contour map of the Vudal College site was completed. Contour intervals of 2 feet were mapped on the flats and an area of approximately 600 acres was covered. Soils were mainly light textured, volcanic ash and pumice derived, and varied considerably as a result of alluvial resorting. Apart from some very steep ground and a small area of swamp, the land was considered suitable for most lowland crops.

RIKAU-TABAI.

This area of 2,407 acres was surveyed in detail. It was one of several blocks investigated in the Cape Hoskins-Talasea area of New Britain. The soils have developed from pumice and volcanic ash and are medium to coarse textured, dark coloured but highly variable over a short distance. It was concluded that 1,595 acres was suitable for cacao and other lowland crops, while a further 370 acres had potential for gardening or coconuts.

GANOKA.

An area of 2,990 acres of generally flat to gently undulating land was investigated at Ganoka near Cape Hoskins. The soils were dominantly yellow brown to grey brown, medium to coarse textured and highly variable alluvials derived from volcanic ash and pumice. The bulk of the land was suitable for coastal tree and garden crops.

BULU, NALUKORU AND WANGU WANGU.

Three areas near the Willaumez Peninsula, of 745, 816 and 1,110 acres respectively, were investigated for sub-division. The entire area was derived from recent volcanic ash and pumice and the soils showed little profile development apart from an organic matter accumulation in the topsoil. Pumice gravel layers were a feature of the soils and while marked variations in profile details were recorded, the incidence of this gravel is expected to have a major influence on subsequent planting. On Bulu and Nalukoru the bulk of the land was considered suitable for cacao and other crops, but on Wangu Wangu the incidence of extensive gravel phases made suitability for cacao suspect.

DAGI RIVER.

An investigation of soils over an area of 2,700 acres of alluvials of the Dagi River near Cape Hoskins was carried out. The soils were again medium to coarse textured over some 1,600 acres of well-drained land, and extremely variable owing to re-deposition of ash and pumice material by the adjacent streams. The well-drained soils had a potential for most coastal crops.

The remainder of the area was less well-drained with some heavier textured gleyed soils, and would be suitable for coconuts.

RECONNAISSANCE SURVEYS.

EASTERN HIGHLANDS.

A reconnaissance was made of approximately 661 square miles of country in the southern Bismarck range around Okapa. Soils were highly variable, reflecting changing conditions of drainage and parent materials, even over short distances on uniform slopes. Suitable maps of the area were not available, so the investigation was confined largely to ground patrols and observation of road cuts. Smaller areas were studied in detail and representative soils described. The soils were dominantly deep brown clays, often eroded on hilly uplands, where soil movement has also given rise to shallower grey soils with somewhat poor drainage. Shales and sandstones outcropped in creeks.

WESTERN HIGHLANDS.

An area of some 20,000 acres in the Baiyer River Valley was surveyed to ascertain its broad potential for tea growing. An area of some 4,000 acres of orange brown well-drained light clay with a dark grey topsoil was suggested as having the greatest potential for future investigations. A number of other soils were described and use was made of aerial photographs in determining the extent of soil areas.

INDIVIDUAL BLOCK INSPECTIONS.

WESTERN HIGHLANDS.

Soil maps were prepared for Ulya and Nunga coffee plantations in the Western Highlands. The soils on both plantations were of alluvial origin, those of Ulya comprising gleyed clays and sandy clays with mucks in drainage lines, while on Nunga they were highly organic dark-coloured clays and mucks.

MISCELLANEOUS.

Less detailed investigations were carried out on blocks of land in the Baiyer River Valley, Wau District, Markham Valley and Eastern Highlands following specific requests.

DIVISION OF EXTENSION AND MARKETING.

In pursuing the objectives outlined in the 1959-60 Annual Report, the Division of Extension and Marketing, which has its headquarters in Port Moresby, operates through its Regional and District Agricultural Officers, together with their staffs of Agricultural Officers in districts and sub-districts, and indigenous Assistant Agricultural Officers and Fieldworkers. The Regional and District Agricultural Officers have the responsibility for organizing all aspects of extension and marketing with European and indigenous farmers, whereas the lower level intermediaries operate entirely with indigenous agriculturalists.

Some discussion of indigenous agriculture is necessary as a background to the activities of the Division.

PRINCIPAL TYPES AND METHODS OF INDIGENOUS AGRICULTURE.

Agricultural production is predominant in the economic life of the people; as well as being responsible for a large proportion of the Territory's export income, it provides the vast majority of the indigenous inhabitants with their subsistence requirements and the basic income needed for their economic advancement.

The main forms of agriculture practised in the Territory are:

- (i) Subsistence farming based on bush and grassland fallowing and the production of root crops as a staple, supplemented by such minor crops as maize, beans and various types of fruit and vegetables.
- (ii) The production of dual-purpose crops (e.g. peanuts and rice) which play a part both as subsistence foods and cash crops, allied with the cash sale of surpluses of the traditional subsistence crops such as bananas, sweet potato, taro and yams.
- (iii) The plantation production of such perennial crops as coconut, cacao and coffee for export. Although in the past production of plantation-type crops has been in the hands of non-indigenous producers, a very rapid growth of indigenous participation in these industries has taken place in recent years, as a result of Agricultural Extension programmes. Indigenous cultivators now control more than half the acreage planted to coffee and are progressing towards half the production potential in the commercial coconut industry. Many of the plantings are as yet immature, and it will be some years before the planting position finds expression in terms of production.

CULTIVATION METHODS AND TECHNIQUES OF THE INDIGENES.

Although indigenous farmers are developing new skills and are increasingly undertaking the specialized production of particular crops as a means of raising their living standards, subsistence production is the economic sheet anchor and will mitigate the effects of any difficulties encountered in particular forms of activity during the period of transition.

There are many ways in which productive efficiency can be increased by the modification of existing techniques, but a degree of caution must be exercised in introducing changes, so that active destruction of agricultural resources may be avoided. The Department therefore maintains a close and continuous survey of agricultural conditions among farmers, and designs its Extension programmes in such a way as to bring about an evolutionary development of indigenous agriculture based on the valuable and conservational aspects of the existing systems. For example, the present basic system of bush or grass fallowing, whilst inefficient in that it requires a major clearing effort each time a crop is planted, is conservational in that the re-growth which takes place in gardens tends to preserve the soil from physical and chemical degradation. Extension programmes aim at showing farmers that they can considerably decrease the labour connected with producing their food requirements by practising a rotation on each clearing before it is abandoned, instead of the older method of taking only one crop before land reverts to bush or grass fallow. It has been found that soil fertility is far from being the only factor governing traditional agricultural practice and that other difficulties, such as build-up in the incidence of pests and diseases, combine to make successive cropping with a single staple impracticable. The lack of foods suitable for storage makes the indigenes dependent on day-to-day harvesting of the perishable staples and subject to the effects of

seasonal variations. Rice and peanuts yield foods which can be stored and fit in well with traditional subsistence methods; farmers are encouraged to expand the production of these crops. Use is encouraged of leguminous covers or quick-growing leguminous trees, which provide only a minor clearing problem, as a substitute in the bush fallow for natural forest growth. It is not yet known precisely to what extent a complete resting period for soils can be deferred.

The production of staple foodstuffs is usually closely interwoven with the social structure and religious beliefs and practices of indigenous communities. Tastes, prejudices, fear of contamination of themselves and of their agricultural land, and the fear of relying on crops with which they are unfamiliar, are some of the difficulties encountered in attempting to diversify and improve the efficiency of agriculture. The use of training programmes in which cultivators are given specific instruction in new methods, and shown the value of new and varied foods, accelerates the adoption of new ideas.

The expansion of perennial crop planting, particularly for cash cropping, introduces specific problems. Perennial crops are of minor importance in the primitive subsistence economy; land tenure systems correspond with the land use methods for the production of the annual staples and land ownership is of little importance in relation to the location of groves of perennials. However, when perennials are used for cash cropping, particularly where formal spacing and techniques other than grove planting are adopted, the attitude to the land involved tends to change radically. For example, where land under tribal conditions changes hands through matrilineal inheritance patterns, men growing perennial crops develop the wish to hand it down through their own lineage. Perennial cash crops have now become an important factor in the economy of many indigenous rural communities in the Territory; this form of planting appears to integrate best with tribal subsistence agriculture when individual plantings are made within the boundaries of land owned by the social group to which the cultivator belongs. Such plantings also have a stabilizing effect on tribal tenure, since groups resist the surrender of such an asset when land is being exchanged during marriage transactions or for similar social reasons. Difficulties will be encountered also in the extension into the indigenous system of mechanized production of annual crops, since, to be profitable, mechanized production requires substantial units of land which can be subjected to uniform cultivation procedures. The ultimate solution to these problems is undoubtedly the rationalization of tribal tenure so that the farmer can be issued with a legal title to replace his tribal right, and the principles to be followed in achieving such a rationalization have been defined.

However, indigenous communities are extremely cautious towards any suggestion of replacing traditional tenure and, in the interim period, new systems of planting can be introduced side by side with subsistence production, provided that there is not a widespread development of permissive occupancy planting outside the land boundaries of effective social units.

A primitive but highly developed system of agriculture which includes the composting of vegetable matter is practised by the Enga people in Wabag Subdistrict. Saucer-shaped depressions are filled with vegetable refuse which is heaped up and covered with fine top soil, making a compost pit. Sweet potato, the local staple food, is planted in this pit. This system offsets the rather poor soil conditions and the warmth generated by the further decomposition of the compost counteracts the effect of the severe cold of the high altitudes.

Another specialized development in traditional land-use practice, which has been revealed by surveys by Agricultural Extension Officers, is the division of garden land into square beds by a lattice of deep trenches. The sub-soil from the bottom of these trenches is thrown up on top of the beds and mixed with the topsoil before planting. This practice is used in the Wahgi Valley. Agricultural Extension officers encourage extension of the use of such beneficial traditional methods in all areas where they increase productivity on poor soils and there has been a notable expansion of their use in the Western Highlands District. With the introduction of coffee as a cash crop, it has been found that farmers are quite willing to accept the principle of mulching because of their past experience of closely allied practices.

In the drier areas of the Eastern Highlands, irrigation is becoming a more common practice as a means of coping with drought problems and resultant food shortages. The matter of ensuring continued food supplies in the frost affected areas of the Highlands continues to receive attention. Good results have been obtained from the partly frost-tolerant European potato variety introduced for this purpose. Planting material from early harvestings of this variety has been widely distributed in the Highlands districts.

In the Chimbu Subdistrict, much of the land under cultivation is on hill slopes. The clearing of forest from these areas has led to erosion by wash and landslides and, in some cases, has tended to destroy catchment areas. The subdistrict has been provided with a specially



Plate 25—*Sago prepared by traditional methods is an important part of the diet in the Western and Sepik Districts.*

[Photo : D.I.E.S.]



Plate 26—*The introduction of the peanut into subsistence agriculture has improved protein nutrition in many areas.*

[Photo : Australian News and Information Bureau.]

selected team of Agricultural Officers, and survey work aimed at assessing the land use situation has continued. Surveys conducted to date show that there is no immediate shortage of land at the present level of production, with the majority of farmers still practising subsistence agriculture, and that overall there are substantial reserves of available land. These surveys have, however, identified the Upper Chimbu Valley area, which has about 10 per cent. of the Sub-district population, as one where problems of land shortage will develop at an early stage of economic expansion. The position of this area is being kept under close examination by agricultural patrols to ensure an early awareness of any need which may arise for resettlement.

In areas where major deterioration of soil and vegetation has resulted from the application of primitive land use methods, particularly from burning for hunting in lower rainfall regions, Agricultural Extension programmes include measures for land reclamation and conservation. A major programme of this type is at present being undertaken in the Eastern Highlands District, the lines of action being the control of burning, including the prosecution of offenders, the encouragement of the people to refrain from cultivating ridge top and watershed areas, and a programme, supported by the supply of suitable tree seedlings, for the recovery of degraded grassland country by afforestation. The programme, which is approved by the farming population, is resulting in natural regeneration of vegetation throughout extensive degraded and eroded areas, in some of which fairly dense stands of young secondary forests are now appearing. There has been a change in emphasis involving the expansion of planting of *Casuarina* species as it has become obvious that this genus is the most widely adapted to land improvement work over a range of soil and climatic types in the highland areas. The planting of *Casuarinas* on old garden land and degraded grasslands has become established as an accepted technique.

STATUS OF INDIGENOUS AGRICULTURE.

In recent years active and expanding Extension programmes have had a noticeable influence on indigenous agriculture. Since about 1956, there has been an increasing diversification of subsistence and cash cropping, particulars of which are given later in this chapter under the heading "Development Plans for Indigenous Agriculture".

There is also marked expansion of the area and output of individual farms, and a greater understanding of the relationship between increased production and increased income. Previously, even when new crops were introduced or larger blocks of particular crops were achieved by co-operative effort, the area worked by individual farmers did not increase. The increase in the size of blocks cultivated by indigenous farmers is particularly evident in the New Britain and Northern Districts in connexion with cacao and in the Eastern Highlands District with coffee, while a similar expansion has been associated with the mechanized production of annual crops in the Markham Valley area of the Morobe District.

Of special significance has been the development during the past two years of individual farms completely outside the traditional agricultural system in the New Britain and Northern Districts, where farmers have taken up blocks on Administration owned land and have been granted formal leasehold tenure.

SURVEY OF INDIGENOUS AGRICULTURE.

A survey of indigenous agriculture in Papua and New Guinea was begun in December, 1960, as part of the 1960 World Census of Agriculture. The data will also be used for purposes of planning and administration. The scope of the survey covers all indigenous agriculture excepting certain recognized types of commercial production which are the subject of ancillary surveys.

The sample design and planning of the survey were undertaken by the Bureau of Census and Statistics of the Commonwealth of Australia. The Department of Agriculture, Stock and Fisheries is responsible for all field operations, which will take eighteen months to complete.

The survey is based on a stratified random sample in which two villages were selected, with probability proportional to size (in terms of population), from each of 50 strata. As the basis of stratification, data were collected on staple diet, climatic conditions, soil, vegetation, topography, population growth, &c., for each census division within the area covered by the survey. Each of the 100 villages selected had received its first visit by 31st May, 1961, and will be visited three times in the course of the survey.

Two major aspects of indigenous subsistence agriculture will be considered:

- (a) statistics of garden area at a point of time and of changes over a period of twelve months;
- (b) area and production statistics for the principal crops.

In addition to the purely agricultural statistics, it is planned to obtain certain demographic data and statistics on implements, livestock and sago production.

DEVELOPMENT PLANS FOR INDIGENOUS AGRICULTURE.

It is the policy of the Division of Extension and Marketing to study the particular needs, opportunities and problems of each district in which it works, and to draw up programmes of Extension work suitable for each particular district, bearing in mind that change can be effective only if it is introduced gradually and is accepted voluntarily by the people. The programmes are kept continually under review and are adjusted to meet changing circumstances.

With present levels of social and educational advancement, it is impossible for the great bulk of the indigenous farming community to conceive of land use procedures as rational systems, or to have a conception of anything like a national or Territorial aim of preserving total agricultural resources through sound and conservational methods. Consultation with the indigenous population is a necessity, but can at present be expected to have no more than a local application. It will, for some years, be necessary for the Administration to accept all of the responsibility for conserving resources.

EVALUATION OF TERRITORY AGRICULTURE.

The main objects of the agricultural development programme for the Territory are:

- (i) to improve indigenous agricultural methods and so increase the total volume of production and the nutritional level of the people;
- (ii) to increase the production of such commodities as rice, meat, dairy products and fresh fruit and vegetables, which are all imported in varying quantities at the present time;
- (iii) to increase the production of certain agricultural crops for export.

During the year under review, the outstanding features of expansion in terms of these objectives were increases in the overall production of cocoa and coffee, and in the planting of coconuts, cacao and coffee by indigenous farmers.

Progress in individual districts is reported below.

SEPIK DISTRICT.

Twenty-six thousand coconut trees were planted during the year, bringing the total under indigenous ownership to 844,000. Copra production for the year totalled 394 tons.

Robusta coffee plantings increased from 27,700 to 92,600 and Arabica coffee from 8,000 to 9,000 trees. One ton of green Robusta coffee was sold. Plate 27 illustrates a typical Robusta coffee garden in the Sepik District.

Because of continued adverse marketing conditions, commercial production of peanuts declined still further to 78 tons.

One hundred and twenty-two tons of rice produced by indigenes was milled and consumed within the district.

MADANG DISTRICT.

Copra production increased to 1,747 tons during 1960-61. Ten thousand new coconut palms were planted, bringing the total to 938,000. Many of these palms are still immature and production should continue to expand in future years.

An additional 29,287 cacao trees were planted in selected areas, bringing the total owned by indigenes to 150,000. Most trees are not yet bearing but production doubled to 40 tons.

The production of rice for sale remained steady, in spite of unfavourable marketing conditions, and amounted to about 110 tons.

There are now 72,800 Arabica coffee trees in the Finisterre Range and 17,750 Robusta coffee trees in the coastal areas. Production of Arabica coffee has begun and during the year 3 tons was sold by growers.



Plate 27—*Robusta* coffee is a cash crop of growing importance in selected lowland areas.

[Photo : D.I.E.S.]



Plate 28—Watershoots must be removed close to the trunk of the cacao tree.

[Photo : D.I.E.S.]

MOROBE DISTRICT.

A major coffee industry had developed among farmers in mountainous areas of this district. Approximately 2,300,000 trees of Arabica have been planted, the largest centre of planting being located in the mountainous hinterland of Finschhafen Sub-district. In addition, 125,000 Robusta coffee trees have been planted in coastal areas. Coffee production increased to 310 tons.

Eleven thousand coconuts were planted during the year bringing the total number of native-owned palms to 465,000. Copra production increased to 365 tons.

Indigenous growers using mechanical farming methods in the level areas of the Markham Valley supplied most of the 250 tons of contract food crops sold at Lae.

One hundred and thirty tons of peanuts was produced during the year, mainly in the Kaiapit Sub-district.

MANUS DISTRICT.

Coconut plantings increased to 56,500 trees and copra production remained steady at 430 tons. Cacao plantings increased to 15,000 trees and coffee to 8,500 trees.

Continued attention was given to annual food crops both for subsistence and for cash sale, and truck crop output rose to 200 tons.

NEW IRELAND DISTRICT.

Coconut planting continued at a rate similar to that of the previous year. Copra production increased to 5,800 tons.

There are 99,000 cacao trees planted in the limited areas suited to that crop. Most trees are immature but production of cocoa beans rose to 75 tons.

Planting of Robusta coffee continued, bringing the total number of trees to 34,000 while 4,000 Arabica trees have been planted in the mountainous inland area. No coffee is yet in bearing.

NEW BRITAIN DISTRICT.

In this district there are approximately 5,000,000 native-owned coconut palms, of which 1,000,000 are not yet bearing. Present annual copra production is 10,000 tons.

Indigenous cocoa production rose from 1,450 tons in 1959-60 to 1,729 tons in 1960-61. Plantings of cacao trees now exceed 3,000,000.

Small plantings of Robusta coffee have been made in the southern areas of the district where the soils are poorer or where the population is too light to provide a satisfactory volume of cocoa for processing purposes.

The resettlement schemes in the Keravat (Vudal) and Warangoi Valleys have shown steady and satisfactory progress. Eight hundred acres of virgin bush has been cleared and one third of this area has been planted with shade trees in preparation for cacao. Over 100 acres has been planted to cacao. An additional area of virgin bush has been sub-divided and allocated to 52 advanced farmers mainly from the Gazelle Peninsula area.

Supplies of truck crops to Rabaul were maintained at 1,500 tons and the market at Rabaul had a turnover in excess of £58,000.

BOUGAINVILLE DISTRICT.

There was an increase in agricultural development throughout the district.

Copra production increased to 2,200 tons and the 1959-1960 rate of coconut planting was maintained.

Cacao planting continued at an increasing rate during 1960-61 and 390,000 trees have now been planted. Most trees are immature but 52 tons of cocoa was produced. Some New Guinean growers in Bougainville conduct their own fermentaries, one of which is illustrated in Plate 29.

Robusta coffee plantings increased to 49,000 trees.

Sales of peanuts have ceased owing to adverse marketing conditions, but rice production increased to 120 tons.

Because of their dependence on annual crops, Rural Progress Societies had a reduced turnover in 1960-61, but this situation will change as cacao and coffee plantings come into bearing.

EASTERN HIGHLANDS DISTRICT.

Arabica coffee plantings continued and Native growers now own more than 2,750,000 trees. Production of green coffee increased to 326 tons. A vigorous campaign to improve coffee quality throughout the district, in part involving the replacement of unsatisfactory metal containers by 4,100 wooden fermenting troughs, was very successful. Coffee owners also took part in a programme of insecticidal treatment of trees in areas subject to infestation with the ring-boring weevil.

Commercial peanut growing has now been incorporated into the agricultural rotation and provides a very nutritious supplementary food as well as a source of cash income. Thirty-five tons of high grade kernels were marketed. More than 200 tons of rootcrops were sold at the main centres in the district.

Passionfruit production suffered a temporary check, 750,000 lb. being delivered to the factory at Goroka. The recent announcement of a substantial increase in the price for raw fruit is expected to revitalize the industry.

Following the success of the pilot tobacco project conducted during 1959-60 in the drier section of the district near Bena Bena, plantings increased; seven tons of leaf were produced in 1960-61, and a quantity exported at satisfactory prices. The standard of planting is illustrated in Plate 30.

WESTERN HIGHLANDS DISTRICT.

Developments in this district are similar to those in the Eastern Highlands, but less advanced because of its greater remoteness and later contact.

During 1960-61, more than 250,000 Arabica coffee trees were planted from nurseries supervised by the Department. Plates 31 and 32 illustrate the type of nursery built in the Highlands. There are now 178,000 mature and 272,000 immature trees. Seventy-one tons of green coffee was produced.

Truck crop production increased to 4,750 tons in 1960-61 and 187,000 lb. of passionfruit was pulped.

Production of peanuts for sale declined because of marketing difficulties, but, as in the Eastern Highlands, peanuts now constitute an important supplementary food crop.

An area near Banz has been selected for a pilot cattle scheme among indigenous farmers and three other areas are to be selected.

SOUTHERN HIGHLANDS DISTRICT.

There was an increase in Agricultural Extension patrolling and good contacts were made with four groups which had not previously been contacted by Agricultural Extension workers.

The growing of Arabica coffee is being encouraged. Five thousand trees have been planted out in groves, and nurseries sufficient for 70,000 seedlings were established.

Experimental plantings of pyrethrum and tobacco were made to determine their suitability as cash crops in the district.

WESTERN DISTRICT.

Agricultural Extension work has aimed at the improvement of copra quality and the distribution of rice, peanuts, maize, and vegetable seeds to improve subsistence agriculture. Trial plantings of Robusta coffee have been made in all sub-districts, the total being 3,800 trees.

Copra production was steady at 60 tons but of higher quality than previously.

GULF DISTRICT.

Papuans produced 38,247 lb. of rubber under an Administration sponsored scheme which commenced during the year at Cupola, near Kerema. Several groups of Papuans attended special courses in budding and plantation management at Bisianumu and Itikinumu rubber plantations in the Central District. Modern high-yielding clonal seed was made available to Papuans interested in planting rubber.

There was a marked increase in copra production, which reached 1,828 tons. Extension workers continued to give attention to the improvement of the standard of maintenance of coconut groves and the quality of copra produced.

The planting of Robusta coffee in suitable areas is being encouraged by Extension workers. There are now over 7,000 trees planted and sufficient nurseries for 50,000 trees have been established.



Plate 29—Some New Guinean cacao growers in Bougainville have built their own fermentaries.

[Photo : D.I.E.S.]



Plate 30—Tobacco is a crop of growing importance to smallholders in the Eastern Highlands.

[Photo : D.I.E.S.]

CENTRAL DISTRICT.

Attention to the promotion of cash cropping with coconuts and improvement of quality continued. Copra production increased to 827 tons.

Attention was given to improving the maintenance of the coffee grown in the Rigo hinterland and the Kuni and Tapini areas. Papuans now own 16,000 Arabica and 16,000 Robusta coffee trees. Most of these are immature and production is expected to increase considerably in the future. Six tons of Arabica coffee was produced.

The annual commercial production of truck crops increased to approximately 2,000 tons. Approximately 1,000 lb. of dry rubber was produced by Papuans during the year.

NORTHERN DISTRICT.

Six thousand coconuts were planted during the year to bring the total to 126,000 trees. These are mainly used for subsistence but 50 tons of copra was produced.

Robusta coffee plantings increased and there are now 327,000 trees planted; most trees are immature. Current production of 24 tons will be greatly increased in future years.

Cacao plantings by Papuans now total 275,000 trees. The groves are well maintained and are expected to yield well when they come into full production. Production for the year was 11 tons.

Rubber production by Papuans increased and 14,000 lb. was produced.

MILNE BAY DISTRICT.

Coconut plantings continued in this district. Fifteen thousand seedling palms were planted to bring the total to 690,000. Copra production by Papuans was 3,500 tons.

Robusta and Arabica coffee plantings continued. There are now 207,900 Robusta coffee trees and 104,000 Arabica coffee trees owned by Papuans in the district. Twenty-four thousand Robusta and 9,500 Arabica trees were planted during the year. Most of the coffee trees are immature but production of coffee began, 5 tons of Robusta and 6 tons of Arabica coffee being produced during the year.

The Village Agricultural Committees and Associations of the district continued to be useful means of agricultural extension.

AGRICULTURAL TRAINING.

Approved training proposals are as follows:

- (a) Full diploma courses to be given at a College on a 700 acre site at Vudal near Kerava in the New Britain District, to students who have successfully completed the Junior Certificate.
- (b) Sub-diploma courses to be provided for students who have passed Territory Standard 9 and desire a specialized training in agriculture. It is proposed to develop the Agricultural Extension Station at Popondetta in Papua into an Institution for this purpose.
- (c) Farmer training courses of nine to twelve months' duration to be given at Agricultural Extension Stations, and, as field training, to small groups at Extension Centres. Full training facilities have been completed at the Madang Extension Station; the Taliligap Extension Centre (New Britain District); the Bainyik Extension Station (Sepik District); and Popondetta (Northern District). Temporary facilities are in use at the Extension Stations at Mount Hagen (Western Highlands); Sohano (Bougainville); Kavieng (New Ireland); Kapogere (Central District); Oriomo (Western District); Kerema (Gulf District); and Mendi (Southern Highlands). At 30th June, 1961, 678 farmer trainees were undergoing courses at stations and centres in the Territory.

Until the institutions mentioned at (a) and (b) above are established, higher level training can be provided for 25 students a year at a temporary training centre at Mageri near Port Moresby.

A copra training school was opened at Aitape in the Sepik District early in 1961, with the aim of improving the output and quality of copra in the district. The school has accommodation for sixteen trainees and conducts courses of six weeks' duration, covering the establishment and management of village copra plantations and the erection and operation of hot-air copra driers of the "New Ireland" type. Villagers are selecting leaders of their communities to attend the school, which has a staff of four indigenous instructors under the general supervision of the Agricultural Officer at Aitape.

AGRICULTURAL EXTENSION STATIONS.

These Stations serve as district regional bases for agricultural extension activities and combine the functions of static demonstration, farmer training, local experimentation and seed production. The Stations at Bainyik (Sepik District); Madang (Madang District); Mount Hagen (Western Highlands District); Kagua (Southern Highlands); Sohano (Bougainville District); Kavieng (New Ireland District); Popondetta (Northern District); Murua (Gulf District); Kapogere (Central District); and Oriomo (Western District) are being developed for the exercise of these functions.

During 1960-61, in addition to farmer training, these Stations continued to provide crop production and processing demonstrations, production and distribution facilities for seed and planting material, and to undertake local experimentation.

AGRICULTURAL EXTENSION CENTRES.

These are small establishments which serve as local bases at the sub-district or area level for such field Extension activities as patrolling, rural organization and marketing assistance, field training and the distribution of seed and planting material. It is the policy to expand the services available to indigenous farmers by developing additional Extension Centres in all districts of the Territory. During 1960-61 new Centres were established at Namatanai in the New Ireland District, Turiboiru in the Bougainville District, and Pomio in the New Britain District, and Extension work was continued from the following centres: Taliligap, Talasea, and Kandrian in the New Britain District; Wewak, Aitape, Yangoru, and Angoram in the Sepik District; Lae, Wau, Kaiapit, Finschhafen, and Pindiu in the Morobe District; Kundiawa, Chuave, Henganofi, Kainantu, Okapa, and Onamuga in the Eastern Highlands District; Bogia, Saidor, and Kar Kar in the Madang District; Konga and Kieta in the Bougainville District; Wabag and Minj in the Western Highlands District; Lorengau in the Manus District; Kuiaro and Orangerie Bay in the Milne Bay District; Kokoda in the Northern District; Beipa and Inauaia in the Central District; Ihu and Kerema in the Gulf District; and Mendi in the Southern Highlands.

AGRICULTURAL PATROLLING AND VILLAGE CONTACTS.

Patrols involving 3,854 days in the field by professional officers and 69,437 days by trained indigenous assistants were carried out. In addition to the normal Extension patrols, patrols to sample villages visited in association with the F.A.O. Survey of Indigenous Agriculture involved more than 1,000 days by professional officers and indigenous assistants. As a result of these activities contact was made with a greater proportion of the rural population and was more intensive than previously.

DEVELOPMENT OF MAJOR PROGRAMMES OF RURAL ORGANIZATION AND MARKETING.

To cater for the considerable expansion of commercial production taking place throughout the Territory, a series of major marketing projects has been organized on an area basis in various districts by the special marketing section set up within the Division of Extension and Marketing to provide processing and marketing facilities for indigenous producers. The projects are organized in such a way as to integrate them with the work on rural organization and marketing being carried out in connexion with such organizations as Rural Progress Societies, Co-operative Societies, and Local Government Councils, and to allow the development of individual enterprise by the indigenes within their framework. The following projects, one of which was started during the year, have been established:

FINSCHHAFFEN PROJECT.

This project is based on the operations of the Finschhafen Marketing and Development Society, which was placed on a firm footing during 1959-60. The Society, whose membership is drawn from all sections of the Finschhafen Sub-district, is organized on co-operative lines and supplies marketing services throughout the sub-district, including sea transport for coffee and copra; it also operates a wholesale distributing service for consumer goods. Within the framework afforded by the Society, individual enterprise is developing at the village level in such fields as coffee pulping and copra drying. During the year, the supervision of this Society was taken over by the Registry of Co-operatives with officers of the Division of Extension and



Plate 31—*The seedbed for coffee must be prepared carefully.*

[Photo : D.I.E.S.]



Plate 32—*Overhead shade and grass mulch are used in coffee nurseries in the Highlands.*

[Photo : D.I.E.S.]

Marketing assisting in the practical side of marketing primary produce. In the coming year, a produce committee is to be set up within the Society to handle all primary produce and marketing under the supervision of Extension officers.

INLAND SEPIK PROJECT.

This project embraces the activities of the four Rural Progress Societies organized in the inland foothill areas on the northern side of the Sepik Valley. A project manager is located at the Bainyik Agricultural Extension Station to give continuous assistance to these Societies, and a central rice mill is established at the same Station to process paddy rice marketed by them. During 1960-61, the Societies again marketed over 100 tons of rice and smaller quantities of peanuts. One ton of Robusta coffee from recently-established trees was produced, purchased and sold in Australia by the Department. As production increases and good marketing conditions are established, the marketing of coffee will be handed over to the Societies.

TOLAI COCOA PROJECT.

This project involves the operation by Local Government Councils in the Gazelle Peninsula area of New Britain of central fermentaries for the processing and marketing of the crop from the very large local cacao plantings. The seventeen fermentaries now established processed over 1,250 tons of cocoa. Processing and handling are comparable with best plantation practice and well known "marks", such as that illustrated in Plate 33, are sought after by buyers. One Agricultural Officer and two Project Managers render full-time assistance to the project.

ASARO-BENA PROJECT.

This project, which was started during the year in the Asaro-Bena area of the Eastern Highlands District, covers the production of coffee, peanuts, passionfruit and tobacco and has a staff of five Extension Officers and a senior Project Manager.

THE CUPOLA RUBBER PROJECT.

This project started in July, 1960, and encompasses the Government-owned Cupola rubber plantation and the indigenous plantings of the Kerema-Ipisi area. The Extension Officer in charge is responsible for the training of present and potential rubber producers from this and other Territory areas in all facets of rubber production. The 108 acres of the Cupola Plantation has been divided into 30 tasks, 24 of which have been leased to neighbouring indigenes on a clanal basis and the other six reserved for training purposes.

The central processing factory is operated by the Department and latex is bought both from lessees and from neighbouring producers. Purchases are for cash on a Dry Rubber Content (D.R.C.) basis. Private producers receive a slightly higher price than lessees who are supplied with tapping materials and other minor requisites.

The price paid to producers was in the range of 18 to 24 pence per lb. D.R.C. and was based on world rubber prices.

Production for the 1960-61 period was:

						lb.
Sheet and clippings	..	..	..	..	..	34,320
Scrap	..	..	..	..	..	3,927
Total ..	..	..	..	..	..	38,247

The Department has established nurseries from Malayan high-yielding clonal seed and the seedlings are sold to indigenous producers at a nominal price. Active Extension work has resulted in new rubber plantings being made by neighbouring people on their own land and a Land Settlement scheme is starting in the nearby Murua area. It is intended that the first stage of the settlement consist of 92 holdings of from 25 to 35 acres each and the bulk of these will be occupied by rubber farmers.

Continuous attention was also given to other aspects of rural organization and marketing. In future years many of these activities will probably be included in area projects of the type mentioned above. Brief reference may be made to the following:

RURAL PROGRESS SOCIETIES.

The association of four coastal and four inland Societies which continued to operate in the Sepik District during the year had a turnover of 54 tons of peanuts and over 300 tons of copra. In Madang District, six Societies marketing mainly rice had a turnover of 100

tons. In Morobe District the Bangalam Society continued to engage in the processing and marketing of rice, while the two Societies engaged in copra and cocoa marketing at Morobe and Bukaua became established and a similar Society was formed at Lei-Wompa. Four Societies are operating in South Bougainville, one at Kieta and three in Buin Sub-district. The Kieta Society is engaged in cocoa marketing while those in Buin Sub-district market rice, peanuts, copra, and basketware.

CO-OPERATIVE SOCIETIES.

The main activity of these Societies in relation to primary production is copra marketing. Continued assistance was provided in the form of training and advice in all areas of the Territory where they operate.

LOCAL GOVERNMENT ORGANIZATIONS.

The Division of Extension and Marketing continued to maintain close liaison with Local Government Councils on matters affecting rural economic development. Particularly valuable assistance was again given by Councils in the Eastern Highlands in organizing field days for demonstrations of production techniques for peanuts and coffee.

DIRECT PURCHASE OF CASH CROPS.

In areas where marketing facilities were either absent or ineffective, direct assistance was given to native farmers through the purchase of their crops by Extension Officers. During 1960-61, crops to the value of £67,000 were purchased in this way, including copra, cocoa, coffee, rice, peanuts, castor seed, tobacco, potatoes, and vegetables. This service provided a particular stimulus to producers in isolated and backward areas.

LAND SETTLEMENT PROJECTS.

The aim of these projects, a series of which is to be established in suitable localities, is to give advanced farmers an opportunity to develop individual holdings under secure conditions of tenure and at the same time demonstrate to other farmers in tribal areas the advantages of individual tenure. During 1960-61, 52 blocks of land suitable for combined cacao and food crop farming were allocated to selected applicants in the Warangoi Valley area of New Britain and 100 blocks were allocated in the Popondetta area of the Northern District. The settlers in each project continued to make good progress with the development of their blocks under the guidance of an Extension Officer who devoted his whole time to this work.

OTHER SERVICES PROVIDED BY THE DIVISION OF EXTENSION AND MARKETING.

OPERATION OF MECHANIZATION SERVICES.

Services to rural producers in regard to cultivation and processing equipment were maintained by Mechanical Equipment Inspectors located at Bainyik, Sepik District; Lae, Morobe District (from which two Inspectors serve the Morobe and Highlands Districts); Rabaul, New Britain District; and Port Moresby. Regional services were provided from Rabaul for the islands lying to the north of New Guinea and from Port Moresby for the whole of Papua, excluding the Southern Highlands District.

PRODUCE INSPECTION SERVICE.

All copra and cocoa for export is inspected by permanent staff at Lae, Madang, Lorengau, Kavieng, Rabaul, Kabakaul (near Rabaul), Port Moresby, and Samarai. Inspections are also made in the Bougainville District as necessary.

CENTRAL PROCESSING FACILITIES.

The operation of processing facilities continued, including coffee-hulling centres at Mount Hagen, Goroka and Lae, a rice-milling centre at Bainyik (Sepik District), and a peanut-hulling plant at Goroka.



Plate 33—New Guinean growers process their cocoa beans in central fermentaries.

[Photo : D.I.E.S.]



Plate 34—A Papuan and a New Guinean staff the Territory exhibit at a metropolitan Agricultural Show.

[Photo : Australian News and Information Bureau.]

DIVISION OF FISHERIES.

A prawning ground with prospects for economic exploitation was discovered at Orangerie Bay in Papua. Several other grounds showed promise for commercial prawning seasonally.

Considerable information was obtained on the habits and habitat of barramundi, which occurs mainly in rivers and estuaries of Western Papua. This species, which is an excellent table fish, occurs in sufficient numbers to be worth commercial development.

Two varieties of carp introduced to the Dobel ponds, Mount Hagen, showed promise for high altitude pond fisheries. The Golden Carp was the more promising. These are the first introduced species to grow rapidly at highland altitudes.

FISHERIES SURVEYS—MARINE.

Twenty-six marine fishery surveys were undertaken in the year 1960–61, 13 in F.R.V. "Tagula", summarized in Table 58, 3 in the Fisheries M.V. "Diama" (1 in company with the Government workboat "Urangah"), 1 in the Government trawler M.V. "Parama", and the remainder in vessels under short-term charter. Table 59 summarizes all surveys in vessels other than F.R.V. "Tagula".

Of the "Tagula" voyages, six were directed wholly or in part towards small-mesh trawling, principally for prawns, and a small beam trawl was used during one survey in the chartered vessel "Diari". Three "Tagula" voyages were concerned with crayfish surveys. Most of the remaining marine surveys involved mesh-netting, principally for barramundi, with special experiments on fish-trapping (Bootless Inlet), shark-lining (Daru) and handlining (Madang). Trolling was undertaken on most voyages. There were short special surveys for whitebait (New Britain), crocodiles (Marshall Lagoon) and mud-crabs (Hall Sound).

PRAWNS.

At least eight species of penaeid prawn were previously known to occur in Papuan waters, but none had been taken in commercial quantities. Early in 1960, F.R.V. "Tagula" was fitted with a new trawl-winch and a prawn-cooker, and in 1960–61 the whole coast from Daru in Western Papua to Lae in New Guinea was surveyed, with special attention to the south-east coast of Papua. These investigations yielded the following results:

- (i) At least one apparently economic ground was discovered at Orangerie Bay and several other grounds promised good prawning at appropriate seasons.
- (ii) In small catches, several species occurred, but on the best grounds, Banana prawn (*Penaeus merguensis*) made up 90 per cent. or more of the catch. Other important species were the Leader and Tiger prawns (*P. monodon* and *P. semisulcatus*), the "Endeavour" prawn (*Metapenaeus* sp., not the Australian species, and probably new), and the Eastern Greasyback (*Metapenaeus macleayi*).
- (iii) Apart from the false Endeavour prawn (the true *M. endeavouri* was also identified), a second new species, not yet identified, was taken. At least five other species were collected, bringing the total to a probable sixteen, excluding non-penaeid shrimps, of which at least five are known.
- (iv) On the best grounds good prawning was available; the best single haul was 331 lb. in 40 minutes, which is seldom exceeded anywhere.
- (v) The new trawl-winch and the modified American trawl-net, as used widely in Australia, were entirely satisfactory in these waters. Other trawl-nets used experimentally included a small trynet for use with small boats.
- (vi) Onboard cooking was satisfactory and the final product of good quality.
- (vii) The local market for prawns was enthusiastic and capable of absorbing larger catches. Prawns sold well at Port Moresby, Samarai and Lae, and would doubtless do so in other centres. In addition, Australian and even American markets are available.
- (viii) At least a few prawns were obtained in almost all likely areas. In other areas, particularly parts of the north coast, the bottom proved to be unsuitable for trawling.

TABLE 58.—SUMMARY OF INVESTIGATIONS BY F.R.V. TAGULA—1960-61.

Fishing Voyage No.	Duration.	Area.	Type of Investigations.	Results.	Remarks.
39	2.8.60 to 9.8.60	Moresby—Otomata (Cheshunt Bay—McFarlane Harbour—Aroma and Wolverine Passages—Baxter Bay—Moresby)	1. Small-mesh trawling, survey and charts	1. 154 lb. prawns	53 hauls, 20.3 minutes average
40	19.7.60 to 9.9.60	Moresby—Mariawatte (Kinikini Bay—Mayri, Baxter, Amazon Bay—Baibara Is., Mariawatte-Gadaisu)	1. Small-mesh trawling 2. Transport of Loupom fish to Moresby market	1. 2,376 lb. prawns, 13,270 lb. small mixed fish (few edible) 2. 500 lb. mackerel, 750 lb. other fish	Adverse weather, 55 hauls (12 days) 29.9 mins. average. Best areas Mariawatte—Gadaisu, Baibara Is., Kinikini; rest poor
41	26.9.60 to 13.10.60	Moresby—Lae— (a) Otomata (b) Orangerie Bay (c) Wanigela R. (d) Milne Bay (e) Collingwood Bay (f) Hercules Bay (g) C. Vogel-Button Is. (h) Tufi (i) Oro Bay (j) Mambare Bay (l) Lae (m) Mud Bay	1. Survey whole coast for trawling 2. Saleability of Loupom fish at Lae 3. Trolling (3 lines)	1. (a) and (d) Poor (b) 300 lb. prawns (c) 1,325 lb. prawns—1 day (e) Few large banana prawns (3 dozen large scallops) 3. (d) Few pike (g) Some pike and mackerel (e-h) 12 lb. mackerel (1 mackerel) (i-j) 1 pike, few mackerel (f and l) Nil	1. (b) Prawns fewer than expected (c) 3 dozen large scallops (f) Promising other seasons (g) and (m) Unsuitable bottom for trawling 2. Not all sold, Lae freezers full 3. Poor
42	17.10.60 to 27.10.60	Lae-Moresby (as above in 41) and— (n) Royal Channel (o) C. Killerton (p) Morobe Harbour	1. Night hand-prawning (at p) 2. Trolling (3 lines) 3. Transport of Loupom fish to Moresby market	1. 25 prawns (1 lb.) 2. (o-p) 192 lb. Spanish mackerel; 35 lb. trevally; other areas poor 3. 753 lb.	1. Handnet by torchlight ebb-tide 2. (o-p) Reefs close inshore. Nil catch at night
43	4.11.60 to 22.11.60	Moresby—Daru— (a) Oriomo R. (b) Bramble Cay	1. Tow M.V. Dama to Daru 2. Mesh-netting Daru area 3. Trolling around (b)	2. 564 lb. barramundi, 463 lb. shark, 165 lb. other meshed fish 3. 151 lb. Spanish mackerel	Engine main exhaust repaired twice at Daru
44	11.1.61 to 27.1.61	Moresby—Daru— (a) Delena-Yule Is. (b) Oriomo-Parama-Jokea	1. Small-mesh trawling (Trawl Nos. 159-204)	(a) 74 lb. prawns plus 22 lb., 350 lb. fish plus 1,100 lb. (b) 80 only prawns (estimated 4 lb.), 110 lb. fish	(a) 10 plus hauls, average 20 minutes each (a) 20 hauls (b) 16 hauls

TABLE 58—continued.

Fishing Voyage No.	Duration.	Area.	Type of Investigations.	Results.	Remarks.
45	2.2.61 to 8.2.61	Moresby-Samarai	1. Trolling	Few fish	Master ill, flown out from Samarai. Relief Master returned Moresby without fishing. Chief of Division and Mr. M. Aylett, B.S.I.P. Fisheries, observational
46	16.2.61 to 28.2.61	Moresby-Kairuku	Crayfish survey	1,818 crayfish brought back to Port Moresby	Run sporadic, 90 per cent. females (5 per cent. with embryos, 50 per cent. immature eggs). Chief of Division aboard
47	9.3.61 to 12.3.61	(a) Moresby-Kairuku (b) Redscar Bay-Moresby	1. Crayfish survey 2. Small-mesh trawling	1. 2,678 crays purchased 2. 25 only mixed prawns, 435 lb. small fish (mainly small pony fish)	1. 6 only damaged 2. Promising ground in season. Numbers of small sand, spanner and blue-swimmer crabs. 5 only hauls
48	15.3.61 to 24.3.61	Moresby— (a) Kairuku (b) Hall Sound	1. Crayfish survey (a) 2. Mud-crab potential (b)	1. 559 purchased 2. 54 purchased	1. Run nearly finished with onset of S.E. season 2. Many other smaller crabs
49	28.3.61 to 30.3.61	Moresby— (a) Redscar Bay (b) Bootless Inlet	1. Fish trapping (a) 2. Small-mesh trawling (b)	1. 1 only spotted rock cod 1 only sweetlip 2. 5 only Tiger prawns, 72 lb. mixed fish, 8 crabs, 16 scallops	1. W.A. snapper trap 2. 7 hauls, 1 11-lb. shark on handline. Possible ground in season
50	7.4.61 to 24.4.61	Moresby— (a) Hula (b) Orangerie Bay (c) Sunken Barrier (d) Abau	1. Netting for troll bait (a) and (b) 2. Small-mesh trawling (a) 3. Trolling (b) and throughout 4. Loupom freezer	1. 4 trays garfish, &c., 10 lb. fish 2. 1,615 lb. prawns, 8,800 lb. small fish 3. 252 lb. 4. Nil	1. Nine hauls 2. 38 hauls, prawns, patchy 3. Echo-sounder out, brief stay only 4. Engine trouble and adverse weather throughout
51	25.5.61 to 9.6.61	Moresby— (a) Daru (b) Bramble Cay (c) Black Rocks (d) Hall Sound-Moresby	1. Escort M.V. <i>Emerald</i> to Daru 2. Trolling throughout 3. Sharklining (a) 4. Mesh-netting (Oriomo) 5. Small-mesh trawling (d)	2. 380 lb. (c) (90 per cent. Spanish mackerel), 12 lb. other areas 3. 60 lb. shark 4. 14 lb. shark and snapper 5. 5 lb. giant tiger, 7 lb. banana prawns, 880 lb. mixed fish	Weather adverse and electrical system failures (a) 5. 8 hauls—crabs, &c., also taken

TABLE 59.—FISHERY SURVEYS BY VESSELS OTHER THAN "TAGULA" 1960-61.

Vessel.	Area.	Duration.	Type of Fishing.	Total Catch (lb.).	Dissected Catch (lb.).	Remarks.
M.V. "Diari" (Charter) ..	Marshall Lagoon	11.7.60 to 20.7.60	1. Gill netting 2. Beam trawling	1,172	1. 324 barramundi 800 shark 2. 48 small mixed fish	2. 11 shots
M.V. "Parama" (Government trawler)	Daru ..	8.8.60 to 15.8.60	Mesh netting ..	7,124	698 barramundi 6,350 shark 76 other	4½-in. and 7-in. mesh Sharks plentiful
M.V. "Diari" (Charter) ..	Marshall Lagoon	8.8.60 to 19.8.60	Gill netting.. ..	496	493 barramundi 3 other	All barramundi in lagoon basin
M.V. "Diari" (Charter) ..	Marshall Lagoon	12.9.60 to 21.9.60	1. Gill netting 2. Crocodile survey	1. 1,330	1. 230 barramundi 1,100 porpoise (bait) 2. 10 crocodiles	Porpoise excellent bait for crocodiles
M.V. "Veilomani" (Charter)	Torui, Kapura and other rivers, North-west New Britain	17.9.60 to 20.9.60	1. Whitebait survey 2. Estuary netting 3. Trolling	1. Nil 2. 1,133 3. 57	2. 530 shark 603 other (mullet, trevally, threadfin, estuary perch)	1. Whitebait not running—a few small fish caught
M.V. "Taru" (Charter) ..	Daru ..	3.10.60	Gill netting.. ..	4,417	293 barramundi 3,480 shark 644 other	Barramundi not yet running
M.V. "Diana" and M.V. "Urungah" (Government workboat)	Daru ..	24.10.60 to 1.12.60	Gill netting.. ..	11,112	7,891 barramundi 3,221 other	Barramundi run began 20.11.60
M.V. "Eros" (Charter) ..	Daru ..	31.10.60 to 9.11.60	Mesh netting ..	701	279 barramundi 40 mackerel 251 shark 131 catfish	6-in., 7-in., 8-in. nets. Barramundi not running Full moon
M.V. "Eros" (Charter) ..	Bramble Cay ..	21.12.60 to 23.12.60	1. Transport of fish, Daru-Moresby 2. Trolling	54	2. 33 mackerel 21 trevally	

TABLE 59—continued.

Vessel.	Area.	Duration.	Type of Fishing.	Total Catch (lb.).	Dissected Catch (lb.).	Remarks.
M.V. "Koro" (Charter) ..	Hankow Reef-Bagabag Island (Madang area)	20.1.61 to 22.1.61	1. Trolling 2. Handlining	168	1. 47 mackerel 104 other 2. 17 mixed reef fish	Fishing late morning and afternoon. No fish at night
M.V. "Diana" (Fisheries)	Daru West Papuan border	21.1.61 to 20.2.61	Gill netting..	2,117	255 barramundi 970 catfish 892 other	Fishing very poor West Coast. Large catfish Morehead River mouth
M.V. "Koro" (Charter) ..	Hankow Reef-Bagabag Island	11.2.61 to 14.2.61	1. Trolling 2. Handlining	454	1. 339 mixed 2. 115 mixed	Night-fishing on reef poor
M.V. "Diana" (Fisheries)	Daru ..	20.2.61 to 3.3.61	Gill netting..	1,867	1,867 barramundi	Five sets Oriomo River mouth and vicinity

- (ix) A considerable run of small prawn-like crustaceans, probably mysids, was sometimes observed in rivers. They might be of use in making "prawn-bread" as in Indonesia.
- (x) Freshwater "prawns" or shrimps, of several species, occur. Some reached considerable size, larger even than the largest Leader prawns. They are utilized by native fishermen in several areas, and it is possible that an organized commercial fishery might be developed.

CRAYFISH.

Three short surveys were made during the crayfish run at Kairuku, February-March, 1961. Crayfish were purchased from Papuans and processed for transport and marketing. Of 5,095 handled, less than a dozen were unmarketable and the product was generally of good standard. The run was irregular in the latter half of February, and even more so early in March. By the end of March, with the onset of the south-east season, few crayfish could be collected.

CRABS.

During the crayfish investigation a brief survey was made of the mudcrab potential at Hall Sound. Only 54 large crabs were purchased and processed, although many smaller specimens were offered for sale.

Small numbers of Blue Swimmer, Sand and Spanner crabs were taken during small-mesh trawling operations. They may be cooked successfully in much the same way as prawns, and might form a small but profitable sideline for commercial prawning.

BARRAMUNDI.

Eight of the marine surveys were directed towards mesh-netting for barramundi, and in addition one survey was carried into fresh water as far up-river as Lake Murray, while shore-based fishing was also carried out. In the marine surveys 14,094 lb. of barramundi was taken, along with quantities of other fish, principally shark. In Lake Murray, 4,219 lb. was caught in one short net in eleven days during the latter part of June. During nine months of operations ending in March, 1961, a fishing team based at Daru took a total of 50,000 lb. of barramundi and shark, some of which is included in the marine survey figures.

The principal findings from these and prior investigations were as follows:

- (i) Barramundi occurred in all the rivers and estuaries of the Western and Gulf Districts, and most of the waterways of the Central District, becoming rarer eastwards, and not found east of Loupom, in New Guinea, or in the off-shore islands. Fishing was poor west of Daru in January-February, but may be better during the spawning run. There may be a correlation between tidal differences and abundance of barramundi, associated with spawning and feeding habits.
- (ii) Barramundi were found on islands up to eight miles off-shore and in fresh water up to 450 miles above tidal influence. They were abundant in Lake Murray, 300 miles from the mouth of the Fly River.
- (iii) The bulk (80 per cent.) of the barramundi were taken during the spawning season, which was fixed at 22nd November, 1960, to 9th March, 1961, over its range, for that year. Other lesser non-spawning runs occurred at times, during July and August.
- (iv) The marine catch was taken mainly during neap tides in very shallow waters. At high tide during the spawning season the fish moved out of the estuaries and fed actively amongst mangroves.
- (v) There was no sign of reproductive activity in freshwater barramundi. All mature fish were taken in brackish, tidal and coastal waters.
- (vi) Barramundi in fresh water were sluggish and full of fat, and had a muddy or earthy flavour. In contrast, salt-water fish were very active and the flesh of good quality.
- (vii) The food of barramundi consisted almost exclusively of fish and crustaceans in varying proportions. Over half the stomachs examined were empty, since netted fish frequently disgorged their food.
- (viii) A number of barramundi have been marked with opercular clip-tags from the beginning of 1961. No tags have been recovered.



Plate 35—Golden carp have shown excellent growth rates at Dobel ponds, Mt. Hagen.

[Photo : D.I.E.S.]



Plate 36—A fish trap used by New Guineans in the Rabaul area.

[Photo : Australian News and Information Bureau.]

*OTHER SPECIES.**SHARK.*

There is a small but steady market for small shark. Quantities of these fish were obtained during estuarine and coastal surveys, and by shark-lining. Of nearly 12,000 lb. recorded during seven surveys, 6,350 lb. was obtained in one week at Marshall Lagoon. An additional 20,000 lb. was taken over nine months by the fishing team at Daru.

ESTUARINE FISH.

Estuarine fish taken included mullet, trevally, threadfin, perch, catfish and herring. Of 3,524 lb. recorded from seven surveys, 1,100 lb. was specifically identified as catfish.

TROLL FISH.

Of 1,540 lb. of fish caught by trolling in eight surveys, 587 lb. was specified as mackerel, although there was probably considerable more. Other fish taken on troll lines were principally trevally, tuna and pike. Trolling in open water was generally poor, with one fair catch in the Northern District of Papua and another in the Madang area of New Guinea. In October, 1960, large schools of bonito were observed between Lae and Tufi where the indigenes take them in quantity on poles at some seasons.

OYSTER.

Oyster cultivation experiments at Milne Bay were continued throughout 1960-61. These experiments were directed at establishing seasonal and local variation in rate of spat-fall, methods of fixation for cultivation and optimal conditions for growth.

Results of the experiments were:

- (i) Extensive surveys revealed at least two satisfactory sites for collecting spat in Milne Bay. An apparent correlation was observed between salinity and rate of spat-fall.
- (ii) Early observations of seasonal variations in spat-fall showed irregularities which have not been correlated with specific climatic conditions.
- (iii) Maximum spat-fall appeared to occur at different levels at different seasons and on different collecting materials.
- (iv) Spat settled best on cockle-shell collectors and satisfactorily on coconut shells. Asbestos-cement plates were inefficient as spat-collectors. Coconut-shell collectors would probably be most satisfactory for commercial cultivation, since the young oysters are not damaged during removal.
- (v) Early results at Gabagabuna indicated that good growth of pontoon-cultivated oysters might be expected in estuaries, where fouling organisms and predators are rare, although flood problems occur.

SCALLOPS.

During prawn investigations, scallops of good commercial type were occasionally obtained, sometimes in fair quantities. This, like the crab catch, might form a small profitable sideline for prawn trawlers.

FISH MEAL.

During prawn investigations, some edible bottom fish, including sole and whiting, were obtained. The bulk of the small-mesh fish catch, however, consisted of small species of little commercial value, sometimes in very large amounts. Some experiments in the preparation of fish meal from fish of this type have been carried out and it is probable that they could be commercialized in this way.

CROCODILES.

During one survey at Marshall Lagoon, ten large crocodiles were shot; this number included a man-eater 12 ft. 2 in. long which had taken five women that year. Porpoise meat was found to be excellent bait.

Another man-eater 14 ft. 4 in. long was shot at Demara village on the Moi River. It had taken a number of people over a period of years.

SEAWEED.

Seaweed samples sent overseas for identification proved to be unsuitable for the preparation of agar-agar. Surveys will be continued to discover suitable beds of commercial weed.

FRESH WATER FISHERIES.

GIANT GOURAMY (*Osphronemus gouramy*).

Of this species, 143 were imported early in 1960-61, 136 having been imported earlier. About 180 escaped into Bomana Lagoon; one batch was sent to Balimo in July, 1960; 25 were sent to Rabaul for experimental culture; 30 had already been taken to Mt. Hagen where apparently none survived; and 40 remained at Bomana experimental ponds at the end of the year.

Results were disappointing; neither growth rate nor population increase in ponds compared with those of such species as carp or *Tilapia mossambica*.

SNAKESKIN GOURAMY (*Trichogaster pectoralis*).

Of 300 imported in 1957 only a few survived to this year, with poor growth and no known reproduction.

TILAPIA (*T. mossambica*).

The original shipment of 250 Tilapia arrived at the end of 1954. This species has bred prolifically and wide distribution throughout the Territory continues, both by man and by natural spread. Small numbers were sent from Port Moresby to Lake Murray, Balimo, Kerema, Rigo, and Bereina.

Small quantities of Tilapia began appearing at Koki market, Port Moresby, for the first time.

CARP (*Cyprinus carpio*).

Two varieties of edible carp were introduced for experimental culture. This fish, most widely cultivated edible species in the world, seems likely also to be the most useful in the Territory. Both varieties bred without artificial stimulus at the Highlands Experimental Station where the Golden or Singapore form seemed the more prolific and good growth was also observed both in adults and in juveniles. This species is illustrated in Plate 35.

Small batches of locally bred Golden carp were distributed to Aiyura (three lots), Madang, Lae, Goroka, Mendi (two lots), Wapenamanda, Mt. Hagen (three lots), Banz, Karanka, Wau and Kandep Lakes.

REFRIGERATION.

A new 180 cubic foot refrigerator was installed at Daru in March, 1961. The Kairuku Co-operative, Yule Island, decided to buy a refrigerator with the assistance of the Fisheries Division. The Loupom freezer, capable of storing two tons of fish, handled considerable quantities, of which 2,023 lb. was transported to Port Moresby, and 750 lb. to Lae by the F.R.V. "Tagula".

A considerable interest by native fishermen in ice-boxes and a heavy demand for ice were notable throughout the year. The scarcity of ice is a major stumbling block to fisheries development in the Territory.

FISHERIES ESTABLISHMENTS.

DARU.

A Fisheries' team operated at Daru for the first nine months of the year. The total catch exceeded 60,000 lb., chiefly barramundi and shark.

MADANG.

The fishery development programme at Madang is designed to aid native fishermen along the coast of New Guinea as far as Murik Lakes. Fishing was carried out under European supervision in several villages, and improved techniques of catching and handling were demonstrated.

Two short surveys of off-shore fishing around Hankow Reefs and Bagabag Island were undertaken with moderately successful results, as in previous years.

The Field Officer stationed at Madang represented the Department at the Training Centre on Fish Processing Technology, Quezon City, Philippines, from 6th March to 14th April, 1961.

KANUDI.

Plans for Stage I, comprising a laboratory and European officer's residence, were finalized and construction began in May, 1961. Stage II will comprise laboratory extensions, an aquarium block, and a technology block. Accommodation for Native laboratory and technology staff, ground staff and fisheries' trainees is also planned.

SYNTHETIC NETTING MATERIALS.

There was a continued and increasing interest in and demand for netting of synthetic materials, chiefly nylon, among Native fishermen. These materials are in general more efficient and have a longer useful life than natural fibres, whether local or introduced, and their use is recommended and encouraged by the Division.

HIGHLANDS EXPERIMENTAL STATION.

A Fisheries biologist was stationed at Dobel near Mount Hagen from October, 1960, to supervise experimental culture of freshwater fish. Five ponds were already stocked and a new one-acre pond was completed and stocked.

The principal work at this station is the controlled breeding of introduced fish. Although quantities of young carp, mainly of the Golden Singapore variety, were produced, this was achieved not by controlled breeding but under natural pond conditions. In this case, relatively few survived. The techniques generally used for this species must apparently be modified for Highland conditions.

Tilapia reproduced prolifically here, as elsewhere, but growth was slower than in warmer lowland waters. Other species did not breed at all, and growth was uneconomical.

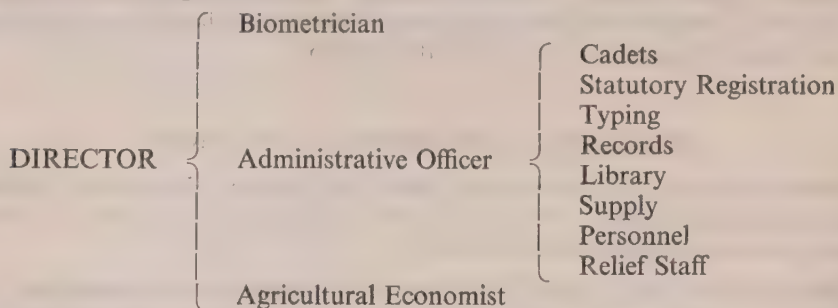
Feeding experiments also continued although the basic staple for all species remained cooked sweet potato. Attention is being given to the artificial cultivation of live food in small ponds, and investigation of the use of piggery effluents is also in progress.

BOMANA QUARANTINE POND.

Small numbers of introduced fishes under investigation are held at Bomana near Port Moresby. Facilities include three concrete ponds and a one-acre irrigation pond for study of fish under natural conditions. Growth of tropical species at Bomana is generally better than in the Highlands, as would be expected, but detailed attention to feeding and care is required for best results.

ADMINISTRATIVE BRANCH.

The organization of the Administrative Branch remained unchanged since publication of the 1959-60 Annual Report and was as follows:



Staff as at 30th June, 1961, comprised 62 officers and employees as follows:

Classification.	Permanent.	Temporary.	Exempt.	Total as at 30th June, 1961.	Establishment.
Biometrician	..	..	..	..	1
Agricultural Economist	..	..	..	..	1
Administrative Officer	1	..	..	1	1
Cadets	21	..	..	21	27
Libraries Officer	..	1	..	1	1
Clerks	8	5	..	13	13
Clerical Assistants	..	1	..	1	2
Clerical Assistants (F)	..	2	..	2	5
Stenographer/Typistes	3	2	..	5	5
Auxiliary Division	6	..	..	6	6
	39	11	..	50	62
Administration Servants	..	..	..	12	12
Total	39	11	..	62	74

ACCOMMODATION.

The Administrative Branch is located in the Departmental Headquarters at Konedobu, Port Moresby. Expansion of accommodation was made possible during the year when part of the office building was vacated by another Department. This area is now occupied by the Library.

CADETS.

Seven Cadet Agricultural Officers and one Cadet Veterinary Officer completed University courses of study and commenced duties in the Territory early in 1961.

BIOMETRICIAN AND AGRICULTURAL ECONOMIST.

Both these positions remained vacant throughout the year, although it is anticipated that a newly appointed Economist from Australia will commence duties late in July, 1961.

Mr. G. A. McIntyre, Senior Principal Scientific Officer of the Division of Mathematical Statistics, Commonwealth Scientific and Industrial Research Organization, has continued to provide a most valuable service by giving advice on the design and analysis of experiments carried out in all Divisions of the Department, and his assistance in this capacity is gratefully acknowledged.

LIBRARY.

The Department maintains a central library which receives over 300 periodicals and numerous pamphlets in addition to books. A continuous circulation of periodicals and books is maintained with over 50 Field Stations and Centres. Branch Libraries are maintained in each District Agricultural Office and also at Experiment Stations and Extension Stations and Centres, the size depending on the number of officers and the type of work they are doing. All Branch Libraries are under the control of the Central Library.

SUPPLY.

The Supply Section processed during the year 555 Indents and 1,362 local requisitions.

PERSONNEL.

As at 30th June, 1961, the Department had in its employ some 650 Administration Servants, as well as over 700 Farmer Trainees and in excess of 800 general labourers. Second, Third and Auxiliary Division Officers totalled 350. The Personnel Section processed approximately 1,800 salary variation advices, 52 new permanent appointments, 22 temporary engagements, 36 resignations and approximately 1,200 allowances and claims.

ACCOUNTS.

Departmental cash expenditure during 1960-61 was £986,019, plus capital purchases of agricultural machinery £18,185, livestock (pigs) £1,960 and livestock freight subsidy of £11,547. Vocabulary stores usage was £169,247. Total expenditure from all sources was £1,186,958.

Included in this expenditure was:

£16,972 for the operation of the Hallstrom Trust at Nondugl.

£67,680 for the purchase from Natives of cash crops for resale.

£16,992 for the payment of air freight and Malayan export duty on improved rubber seed from overseas.

Receipts totalled £103,746 compared with £128,619 for 1959-60. The decrease was caused in the main by the fall in the price of copra and the smaller volume of native cash crops sold. At the end of the year the Department retained excessive unsold stocks of these cash crops. Receipts for the sale of livestock fell by some £5,000 but disposals of store cattle had been greater than usual in the previous year.

STAFF, DEPARTMENT OF AGRICULTURE, STOCK AND FISHERIES AT 30th JUNE, 1961.

Director	..	..	..	..	F. C. Henderson, B.Sc.Agr. (Syd.), M.L.C.
Typiste	..	..	..	..	Miss P. E. Evans

HEADQUARTERS DIVISION.

Agricultural Economist	..	..	..	G. R. Spinks, B.Sc. (Syd.)
Administrative Officer	..	..	..	G. E. Guthrie

Accounts Section:

Clerk (Accounts)	..	..	..	V. S. Poole
Clerk	..	..	..	P. M. Kysely
Clerk	..	..	..	Mrs. J. King
Clerical Assistant, Grade II.	..	..	..	Mrs. E. M. Kelly

Personnel Section:

Clerk (Personnel)	..	..	..	P. A. Chandler
Clerk	..	..	..	N. S. Kenna
Clerk	..	..	..	B. E. Wish-Wilson
Assistant (Clerical)	..	..	..	Kila Mega

Statutory Registration Section:

Clerk	..	..	..	Mr. V. J. Dagge
-------	----	----	----	-----------------

Records Section:

Clerk (Records)	..	..	..	Mrs. M. B. Reid
Clerical Assistant, Grade III.	..	..	..	J. W. Page
Clerical Assistant, Grade I.	..	..	..	Mrs. B. T. Hymus
Typiste	..	..	..	Miss M. A. Barnes
Assistant (Clerical)	..	..	..	Raka Ipi
Assistant (Clerical)	..	..	..	Homoka Doriga
Assistant (Clerical)	..	..	..	Morea Hila

Supply Section:

Clerk (Supply)	..	..	..	G. R. Broadby
Typiste	..	..	..	Miss A. Baker
Assistant (Clerical)	..	..	..	Arua Rei

Cadets:

Cadet Agricultural Officers	..	..	..	R. F. Anders
				R. G. Beneke
				P. R. B. Blood
				G. P. Campbell
				G. K. Chan
				D. C. Cresswell
				L. A. Douglas
				R. A. Eivers
				G. G. Johns
				A. J. Kimber
				W. A. Layton
				N. J. Mendham
				R. P. McKillop
				D. C. Petty
				T. J. B. Quinlan
				P. G. E. Searle
				R. G. Stafford
				K. J. Witting
Cadet Veterinary Officers	..	..	..	J. A. Hamilton
				P. R. Harvey
				D. J. Purdy
				N. T. Talbot

Library:

Libraries Officer	..	..	..	Mrs. E. A. Anderson, B.A., Dip.Ed. (Qld.)
-------------------	----	----	----	---

DIVISION OF ANIMAL INDUSTRY.

Headquarters:

Chief of Division ..	J. L. Anderson, B.V.Sc. (Qld.)	
Senior Stock Inspector	W. C. Jamieson	<i>Stock and meat inspection</i>
Typiste	Mrs. M. A. Ahern	

Veterinary Laboratory, Kila:

Senior Veterinary Officer	J. R. Egerton, B.V.Sc. (Qld.), Dip.Bact. (Lond.)	<i>Pathology and Bacteriology services and research</i>
Veterinary Grade I. Officer,	Mrs. P. K. Abbott, B.V.Sc. (Syd.)	<i>Pathology and Bacteriology services and research</i>
Field Supervisor, Grade II.	C. T. Coghlan	
Typiste	Mrs. A. M. Coghlan	

Central District:

Veterinary Grade I. Officer,	D. M. Keenan, B.V.Sc. (Qld.) ..	<i>Veterinary Officer, Port Moresby</i>
Stock Inspector, Grade I.	R. D. E. Rankin, Q.D.A.H. ..	<i>Stock Inspector, Sogeri</i>
Stock Inspector, Grade I.	C. W. H. Graham	

Papuan Lowlands Livestock Station, Moitaka:

Livestock Grade III. Officer,	D. E. Murray, Q.D.A.H. ..	<i>Station Manager</i>
Field Supervisor, Grade I.	D. Moodie	
Field Supervisor, Grade I.	N. Nelson	
Overseer	G. D. Gooding	
Overseer	C. J. Collinson	

Papuan Highlands Livestock Station, Bisianumu:

Manager, Grade III. ..	D. P. McColm	<i>Station Manager</i>
Livestock Grade I. Officer,	M. G. Meadows, Q.D.A.H.	
Female Assistant ..	Mrs. E. I. McColm	

Morobe District:

Veterinary Grade II. Officer,	T. L. W. Rothwell, B.V.Sc. (Syd.)	<i>District Veterinary Officer</i>
-------------------------------	-----------------------------------	------------------------------------

Animal Industry Centre and Quarantine Station, Three Mile, Lae:

Manager, Grade II. ..	J. L. Cunliffe	<i>Officer-in-charge</i>
-----------------------	----------------------	--------------------------

New Guinea Lowlands Livestock Station, Erap:

Veterinary Grade II. Officer,	J. D. Glasgow, B.V.Sc. (Qld.) ..	<i>Officer-in-charge</i>
Field Supervisor ..	B. I. Sutherland	
Overseer	B. J. Colbran	
Overseer	P. A. Ireland	
Female Assistant ..	Mrs. N. V. Colbran	

*Eastern Highlands District:**Animal Industry Centre, Goroka:*

Manager, Grade II. ..	M. J. Lewis	<i>Station Manager</i>
-----------------------	-------------------	------------------------

Western Highlands District:*Western Highlands Livestock Station, Baiyer River:*

Manager, Grade III. . .	W. N. St. George . . .	<i>Station Manager</i>
Overseer	C. F. Clements	
Overseer	I. W. Shaw	
Field Supervisor, Grade I.	C. R. Kempson	
Assistant Agricultural Officer	G. English	
Female Assistant . .	Mrs. M. St. George	

Hallstrom Livestock Station, Nondugl:

Field Supervisor, Grade I.	F. B. Pemble-Smith . . .	<i>Station Manager</i>
Overseer	G. J. McKinnon	

Banz:

Stock Inspector, Grade II.	A. Hantsoo	<i>Stock Inspector, Western Highlands</i>
----------------------------	----------------------	---

New Britain District:*Animal Industry Centre, Karakakaul:*

Field Supervisor, Grade I.	A. G. Howard	<i>Station Manager</i>
Overseer	A. E. Blumson	

Rabaul:

Stock Inspector, Grade II.	A. R. Savage	<i>Stock Inspector, New Britain</i>
----------------------------	------------------------	-------------------------------------

Madang District:

Stock Inspector, Grade II.	F. L. Corbett	<i>Stock Inspector, Madang District</i>
----------------------------	-------------------------	---

DIVISION OF PLANT INDUSTRY.**Headquarters:**

Chief of Division . .	A. W. Charles, B.Sc.Agr. (Syd.), M.Sc. (Cantab.)	
Typists	Miss S. M. Devine Miss G. Q. E. Crawford	

Agricultural Chemistry:

Principal Chemist . .	D. W. P. Murty, B.Sc.Agr. (Syd.)	<i>Copra quality studies, general and industrial chemistry</i>
Senior Chemist . . .	P. J. Southern, B.Sc. (W.A.) . .	<i>Plant nutrition and soil fertility</i>
Chemist, Grade II. . .	Miss P. M. Thorne, B.Sc. (Qld.) . .	<i>Plant analysis</i>
Chemist, Grade I. . .	Miss C. A. Fowler, B.Sc. (Melb.) . .	<i>Soil and plant analysis</i>
Analyst	C. C. Martin, B.Sc.Agr. (Syd.) . .	<i>Soil analysis</i>
Laboratory Assistant, Grade II.	Mrs. D. A. Conyard, Dip. Chem.	<i>Soil analysis</i>
Laboratory Assistant . .	Morea Raka	
Technical Assistant . .	Jeremiah Iewa	
Technical Assistant . .	Peterson Ataembo	

Economic Entomology:

Senior Entomologist . .	J. J. H. Szent-Ivany, Ph.D. (Buda-Pest)	<i>Systematic entomology and zoogeography</i>
Entomologist, Grade II.	A. C. Catley, B.Sc.Agr. (Syd.) . .	<i>Economic and systematic entomology</i>

Plant Introduction and Quarantine:

Plant Introduction Officer	G. P. Keleny, B.A. (Qld.), D.D.A.
Technical Assistant ..	Gumia Gitti
Technical Assistant ..	John Tilip

Plant Pathology:

Principal Plant Pathologist	Miss D. E. Shaw, M.Sc.Agr. (Syd.), Ph.D. (Man.)	<i>Pathology and taxonomic mycology</i>
Plant Pathologist, Grade I.	M. J. Trinick, B.Sc.Agr. (Syd.) ..	<i>Microbiology (Rhizobium)</i>
Laboratory Assistant, Grade I.	Horatius Igua	
Technical Assistant ..	Reggie Manuda	

Soil Survey:

Principal Soil Survey Officer	G. K. Graham, B.Sc.Agr. (Syd.), D.T.A. (Trin.)	<i>Land use investigations</i>
Soil Survey Officer, Grade II.	T. R. Morgan, B.Sc.Agr. (Syd.)	<i>Soil survey and drainage investigations</i>
Soil Survey Officer, Grade II.	B. G. Williams, B.Agr.Sc. (S.A.) ..	<i>Land settlement investigations</i>
Soil Survey Officer, Grade II.	A. C. Hartley, B.Agr.Sc. (Qld.) ..	<i>Soil survey and settlement investigations</i>
Soil Survey Officer, Grade I.	F. P. Aland, B.Agr.Sc. (Qld.) ..	<i>Land use and settlement investigations</i>
Soil Survey Officer, Grade I.	J. A. Kelly, B.Sc.Agr. (Syd.) ..	<i>Land settlement investigations</i>
Technical Assistant ..	Forova Kulu	
Technical Assistant ..	Iwa Alu	
Technical Assistant ..	Noka Kopi	
Technical Assistant ..	Seaka Kabua	
Technical Assistant ..	Soldier Piki	
Technical Assistant ..	Titus Tatauro	

Experiment Stations:*Lowlands Agricultural Experiment Station, Keravat:*

Principal Agronomist	R. S. Carne, B.Agr.Sc. (Melb.), D.T.A. (Trin.)	<i>Coffee improvement</i>
Principal Entomologist	G. S. Dun, B.Sc.Agr. (Syd.) ..	<i>Economic entomology (biological control)</i>
Senior Agronomist ..	K. Newton, B.Sc.(Agr.) (W.A.), D.T.A. (Trin.)	<i>Cacao improvement</i>
Agronomist, Grade III.	A. E. Charles, B.Sc.Agr. (Syd.) ..	<i>Coconut improvement</i>
Agronomist, Grade II.	J. B. O'Donohue, B.Agr.Sc. (Qld.)	<i>Cacao processing and manila hemp breeding</i>
Agronomist, Grade II.	G. I. Jamieson, B.Agr.Sc. (Qld.) ..	<i>Food crop improvement and rotation trials</i>
Entomologist, Grade II.	L. Smee, B.Sc.Agr. (Syd.) ..	<i>Economic entomology (chemical control)</i>
Plant Pathologist, Grade II.	R. J. van Velsen, M.Agr.Sc. (S.A.)	<i>Virology</i>
Horticulturist / Experimentalist, Grade I.	C. D. H. Scott	<i>Cacao propagation</i>
Field Supervisor, Grade II.	R. J. Kelly	
Clerk	L. C. Penders	
Typiste	Miss R. Schneider	
Labour Supervisor ..	J. B. McNicoll	
Plant Operator ..	L. Enkera	
Mechanic	R. C. Lucker	
Technical Assistant ..	Orula Kakaito	
Technical Assistant ..	Mesulam Wanariu	

*Experiment Stations—continued.**Highlands Agricultural Experiment Station, Aiyura:*

Senior Agronomist ..	A. J. Schindler, M.C., B.Agr.Sc. (Qld.)	<i>Pyrethrum breeding</i>
Entomologist, Grade II.	J. H. Barrett, B.Agr.Sc. (Qld.) ..	<i>Pests of coffee and vegetable crops</i>
Agronomist, Grade I.	R. R. Fraser, B.Sc.(Agr.) (W.A.)	<i>Coffee agronomy and breeding</i>
Horticulturist / Experimentalist, Grade I.	K. H. van Horck, Dip. Hort. (Boskoop)	<i>Propagation of coffee</i>
Field Supervisor, Grade II.	H. Nitsche, Dip. Ag. ..	<i>Livestock and pastures</i>
Technical Assistant ..	Konido Mara	
Technical Assistant ..	Nou Matea	

Epo Agricultural Experiment Station:

Agronomist, Grade II.	P. L. Stallwood, B.Sc.(Agr.) (W.A.)	<i>Rice breeding and agronomy</i>
Field Supervisor, Grade I.	C. B. Mayoh	
Mechanic ..	C. W. Farmer	
Female Assistant ..	Mrs. E. A. Andersson	
Carpenter ..	G. English	
Technical Assistant ..	Joseph Paraha Hau	

Bubia Plant Industry Centre:

Entomologist, Grade II.	J. H. Ardley, B.Sc. (Wellington) ..	<i>Pests of cacao and coconuts</i>
Agronomist, Grade II.	C. S. Edwards, B.Sc.Agr. (Syd.) ..	<i>Agrostology</i>
Agronomist, Grade I.	K. T. Blackburn, B.Sc.Agr. (Syd.)	<i>Cacao die-back and annual crops</i>
Field Supervisor, Grade II.	W. J. Hughes ..	<i>Station Manager and fibre processing</i>

Laloki Plant Introduction and Quarantine Station:

Horticulturist / Experimentalist, Grade II.	R. S. Montgomery, Q.D.H. ..	<i>Station Manager</i>
Horticulturist / Experimentalist, Grade I.	R. G. Whalley ..	<i>Tobacco</i>
Technical Assistant ..	Kana Aburu	

Bisianumu Rubber Centre:

Horticulturist / Experimentalist, Grade II.	A. J. H. Van Haaren, Dip. Hort. (Boskoop)	<i>Rubber propagation and trials</i>
---	---	--------------------------------------

Garaina Experimental Tea Plantation:

Manager, Grade III. ..	T. G. Henderson ..	<i>Station Manager, commercial tea production</i>
Field Supervisor, Grade I.	J. Vermeer	

Yambi Experimental Plots:

Field Supervisor, Grade I.	G. Johnston	
----------------------------	-------------	--

DIVISION OF EXTENSION AND MARKETING.

Headquarters:

Chief of Division	..	W. L. Conroy, B.Sc.Agr. (Syd.)
Principal Agricultural Officer ..	..	J. C. Lamrock, B.Sc.Agr. (Syd.), D.T.A. (Trin.)
Agricultural Officer, Grade III.	..	S. P. Saville, B.Sc.Agr. (Syd.), D.T.A. (Trin.), Dip.Ed. (Syd.)
Agricultural Officer, Grade III.	..	M. J. White, D.D.A.
Agricultural Officer, Grade II. . .	..	W.R. Stent, B.Agr.Sc. (Melb.), D.T.A.(Trin.)
Agricultural Officer, Grade I. . .	..	B. A. Boniwell, B.Agr.Sc. (Melb.)
Agricultural Officer, Grade I. . .	..	W. J. B. Heath, R.D.A.
Agricultural Officer, Grade I. . .	..	T. W. Langton, B.Agr.Sc. (Qld.), Q.D.A.
Senior Mechanical Equipment Inspector		A. W. Jefford, M.I.A.E.
Typiste	..	Mrs. L. M. Stephens

Central District:

Agricultural Officer, Grade III.	..	F. H. A. Klechkam, O.B.E., Q.D.A.
Agricultural Officer, Grade III.	..	G. L. Edwards, H.D.A.
Agricultural Officer, Grade I. . .	..	P. E. Owers, Q.D.A.
Agricultural Officer, Grade I. . .	..	L. F. Green, D.D.A.
Agricultural Officer, Grade I. . .	..	J. C. Hall, D.D.A.
Agricultural Officer, Grade I. . .	..	J. D. W. Ross, Q.D.A.
Agricultural Officer, Grade I. . .	..	W. R. Tapsall, Q.D.A.
Agricultural Officer, Grade I. . .	..	W. J. McKean, L.D.A.
Agricultural Officer, Grade I. . .	..	I. G. Pendergast, D.D.A.
Agricultural Officer, Grade I. . .	..	A. G. Terry, W.D.A.
Agricultural Officer, Grade I. . .	..	B. P. Arney, M.D.A.
Assistant Agricultural Officer ..	..	G. D. Gorogo
Produce Inspector, Grade II. . .	..	W. H. Spencer
Produce Inspector, Grade I. . .	..	G. W. Gaskell
Mechanical Equipment Inspector	..	J. C. Harley
Field Supervisor, Grade II. . .	..	W. A. Thistlethwaite
Clerk	..	H. R. Monaghan
Clerk	..	B. J. Gough
Typiste	..	Miss A. J. Kirschner
Field Assistant	..	Albert Tola Luckie
Field Assistant	..	Erico Foieke
Field Assistant	..	Geno Gideon
Field Assistant	..	John Kanini Koniel
Field Assistant	..	Kaekae Avaisa
Field Assistant	..	Rupa Ora

Milne Bay District:

Principal Agricultural Officer ..	..	W. Cottrell-Dormer, M.Agr.Sc. (Qld.).
Agricultural Officer, Grade II.	..	K. I. Tomlin, W.D.A.
Agricultural Officer, Grade I. . .	..	E. Mobbs, H.D.A.
Agricultural Officer, Grade I. . .	..	J. H. Gosbell, H.D.A.
Agricultural Officer, Grade I. . .	..	J. C. Owen-Turner, Q.D.A.
Agricultural Officer, Grade I. . .	..	D. I. Murrie, R.D.A.
Agricultural Officer, Grade I. . .	..	H. P. Vellacott, H.D.A.
Field Supervisor, Grade II. . .	..	J. D. Davis
Produce Inspector, Grade I. . .	..	F. H. Carstensen
Produce Inspector, Grade I. . .	..	W. H. Hastie
Clerk	..	P. Fumeaux
Female Assistant	..	Mrs. C. J. Petrides
Female Assistant	..	Mrs. P. Davis
Field Assistant	..	Annas Liasina
Field Assistant	..	Charlesford Madiorote
Field Assistant	..	Edric Terenaki Kaieni
Field Assistant	..	Edward Nigea
Field Assistant	..	Gabriel Nicholas
Field Assistant	..	Gottae Muia
Field Assistant	..	Jehosophat Ganubela
Field Assistant	..	Nerrius Tietam
Field Assistant	..	Saki Metu

Western Highlands District:

Agricultural Officer, Grade III.	..	G. N. Angell, M.D.A.
Agricultural Officer, Grade I. ..	..	H. A. Mulder, Dip.Agr. (Deventer)
Agricultural Officer, Grade I. ..	..	G. P. Xavier, M.D.A.
Agricultural Officer, Grade I. ..	..	R. M. Burnett, Q.D.H.
Agricultural Officer, Grade I. ..	..	D. V. Slee, R.D.A.
Agricultural Officer, Grade I. ..	..	R. N. Amos, L.D.A.
Agricultural Officer, Grade I. ..	..	D. A. Haney, M.D.D.
Female Assistant	..	Mrs. N. M. Allan
Field Assistant	..	Aloysius Foma
Field Assistant	..	Peter Mage
Field Assistant	..	Sixtus Baisiro

Northern District:

Agricultural Officer, Grade I. ..	..	M. H. M. Belfield, L.D.A.
Agricultural Officer, Grade I. ..	..	F. K. Mayer, H.D.A.
Agricultural Officer, Grade I. ..	..	J. C. Van Schilfgaarde, Dip.Agr. (Deventer)
Agricultural Officer, Grade I. ..	..	R. J. Cheetham, B.Sc.Agr. (Syd.)
Agricultural Officer, Grade I. ..	..	A. R. Fischle, H.D.A.
Agricultural Officer, Grade I. ..	..	T. W. Huthnance, H.D.A.
Field Supervisor, Grade I. ..	..	J. W. Bell
Field Assistant	..	Luke Genau
Field Assistant	..	Simon N'gu Foike

Western District:

Agricultural Officer, Grade II.	..	F. J. Brockhall, Dip.Agr. (Deventer)
Agricultural Officer, Grade II.	..	G. M. Hawley, M.D.A.
Agricultural Officer, Grade I. ..	..	R. B. E. Smith, H.D.A.
Agricultural Officer, Grade I. ..	..	R. W. Waters, H.D.A.

Gulf District:

Agricultural Officer, Grade III.	..	F. X. Ryan, H.D.A.
Agricultural Officer, Grade I. ..	..	D. Birmingham, Q.D.A.
Agricultural Officer, Grade I. ..	..	J. Christensen, Q.D.A.
Agricultural Officer, Grade I. ..	..	W. N. Fullerton, Q.D.A.H.
Project Manager, Grade I. ..	..	A. B. Wales
Field Assistant	..	James Eki Mopio
Field Assistant	..	Mesea Mesea
Field Assistant	..	Weda Eluida

Southern Highlands District:

Agricultural Officer, Grade I. ..	..	F. Arndt, Q.D.A.
Agricultural Officer, Grade I. ..	..	R. Barrass, R.D.A.
Agricultural Officer, Grade I. ..	..	R. N. Amos, L.D.A.

Eastern Highlands District:

Agricultural Officer, Grade III.	..	D. J. Kingston, Q.D.A.
Agricultural Officer, Grade III.	..	K. S. Cole, B.Sc.(Agr.) (W.A.)
Agricultural Officer, Grade I. ..	..	P. B. Allan, B.Agr.Sc. (Melb.)
Agricultural Officer, Grade I. ..	..	D. J. Edwards, B.A. (Cantab.)
Agricultural Officer, Grade I. ..	..	G. H. Dick, B.Sc.Agr. (Syd.)
Agricultural Officer, Grade I. ..	..	A. D. Hunt, M.R.A.C., A.I.C.T.A.
Agricultural Officer, Grade I. ..	..	K. G. R. Newton, Q.D.A.
Agricultural Officer, Grade I. ..	..	J. J. Nitsche, Q.D.A.
Agricultural Officer, Grade I. ..	..	R. E. Teale, D.D.A.
Agricultural Officer, Grade I. ..	..	K. J. Ainsbury, Q.D.H.
Agricultural Officer, Grade I. ..	..	G. G. Collett, H.D.A.
Agricultural Officer, Grade I. ..	..	R. W. Taylor, Q.D.A.
Agricultural Officer, Grade I. ..	..	L. G. W. Tilley, Q.D.A.
Project Manager, Grade III. ..	..	R. B. Duncan
Female Assistant	..	Mrs. A. T. Tuza
Field Assistant	..	Hetei Esau Dickson
Field Assistant	..	Justus Warari Gau

Madang District:

Agricultural Officer, Grade III.	..	J. R. Vicary, D.D.A.
Agricultural Officer, Grade III.	..	R. W. Cottle, Q.D.A.
Agricultural Officer, Grade I. ..	..	R. E. McCormac, H.D.A.
Agricultural Officer, Grade I. ..	..	B. J. Beil, Q.D.A.
Agricultural Officer, Grade I. ..	..	R. J. Brown, H.D.A.
Agricultural Officer, Grade I. ..	..	C. J. Choat, B.Sc.Agr. (Syd.)
Agricultural Officer, Grade I. ..	..	J. M. MacEwan, H. D. A.
Agricultural Officer, Grade I. ..	..	G. J. Bastyan, M.D.A.
Produce Inspector, Grade I. ..	..	D. S. Askew
Manager, Grade II.	..	N. B. Blood
Typiste	..	Mrs. B. G. Green
Field Assistant	..	David Clark Furifuri
Field Assistant	..	Tom Nayala

Sepik District:

Agricultural Officer, Grade III.	..	D. R. Carey, Q.D.A.
Agricultural Officer, Grade II.	..	D. C. A. Shepherd, M.D.A.
Agricultural Officer, Grade II.	..	J. H. Sharp, D.D.A.
Agricultural Officer, Grade I. ..	..	M. J. C. Griffiths, M.D.A.
Agricultural Officer, Grade I. ..	..	A. G. Govaars, W.D.A.
Agricultural Officer, Grade I. ..	..	P. F. Koch-Emmery, B.Sc.Agr. (Syd.)
Agricultural Officer, Grade I. ..	..	R. W. Arnison, B.Sc.Agr. (Syd.), Dip.Ed. (Syd.)
Agricultural Officer, Grade I. ..	..	R. J. Lancaster, H.D.A.
Agricultural Officer, Grade I. ..	..	B. F. Keane, Q.D.A.H.
Agricultural Officer, Grade I. ..	..	I. L. Thomas, R.D.A.
Project Manager, Grade I. ..	..	J. I. Burgin
Mechanic	..	H. G. Noy
Clerk	..	A. H. Crichton
Assistant	..	Mrs. K. G. Noy
Field Assistant	..	Nerga Mark

Manus District:

Agricultural Officer, Grade I. ..	..	P. U. C. Hermann, Q.D.A.
-----------------------------------	----	--------------------------

Morobe District:

Senior Agricultural Officer ..	..	E. R. Wilson, Q.D.A.
Clerk (Regional)	..	P. C. Marvell
Mechanical Equipment Inspector	..	A. G. Donaldson, A.M.I.A.E.
Agricultural Officer, Grade I. ..	..	J. A. Wallis, H.D.A.
Agricultural Officer, Grade I. ..	..	P. R. Dillon, H.D.A.
Agricultural Officer, Grade I. ..	..	D. W. P. Macauley, H.D.A.
Agricultural Officer, Grade I. ..	..	A. N. Gillison, Q.D.A.
Agricultural Officer, Grade I. ..	..	J. K. Oates, H.D.A.
Agricultural Officer, Grade I. ..	..	J. Matheson, N.D.A.
Agricultural Officer, Grade I. ..	..	B. J. Kebby, H.D.A.
Agricultural Officer, Grade I. ..	..	J. L. Wellwood, D.D.A.
Agricultural Officer, Grade I. ..	..	W. B. Gliddon, R.D.A.
Mechanic	..	W. A. Cotton
Produce Inspector, Grade II. ..	..	J. A. Phillips
Project Manager, Grade I. ..	..	T. Otterspool
Typiste	..	Miss M. M. Wright

New Britain District:

Senior Agricultural Officer ..	..	J. W. Barrie, B.Sc.Agr. (Syd.), D.T.A. (Trin.), Dip.Ed. (Syd.)
Agricultural Officer, Grade III.	..	R. L. Pulsford, B.A. (Syd.), H.D.A.
Agricultural Officer, Grade II.	..	M. J. Mead, R.D.A.
Agricultural Officer, Grade I. ..	..	N. M. Alcorn, Q.D.A.
Agricultural Officer, Grade I. ..	..	J. I. Cox, H.D.A.
Agricultural Officer, Grade I. ..	..	B. R. Johnston, R.D.A.
Agricultural Officer, Grade I. ..	..	D. E. Montgomery, H.D.A.
Agricultural Officer, Grade I. ..	..	P. F. Matthews, M.D.A.

New Britain District—continued.

Agricultural Officer, Grade I. . .	..	R. Tevlin, R.D.A.
Agricultural Officer, Grade I. . .	..	B. Coghill, W.D.A.
Agricultural Officer, Grade I. . .	..	D. R. McKenzie, B.Agr.Sc. (Melb.)
Labour Officer, Grade I. . .	..	J. P. Swanston
Senior Produce Inspector . .	..	F. A. Rhoades, D.S.C., H.D.A.
Produce Inspector, Grade II. . .	..	B. W. George
Produce Inspector, Grade I. . .	..	R. T. Collings
Produce Inspector, Grade I. . .	..	D. S. Mullaly
Produce Inspector, Grade I. . .	..	J. A. Wilkinson
Produce Inspector, Grade I. . .	..	D. H. McLean
Produce Inspector, Grade I. . .	..	W. Gossner
Produce Inspector, Grade I. . .	..	J. H. Rudd
Produce Inspector, Grade I. . .	..	A. M. Squires
Produce Inspector, Grade I. . .	..	P. Reid
Registrar/Manager	..	W. A. Ovenstone
Field Assistant	..	C. L. Slinger
Mechanic	..	H. D. Watt
Clerk	..	L. J. Pipes
Typiste	..	Miss P. Towner
Field Assistant	..	Moses Simeon
Field Assistant	..	Robin Kumaina

Bougainville District:

Agricultural Officer, Grade II. . .	..	R. E. Curtis, D.D.A.
Agricultural Officer, Grade I. . .	..	W. F. Minchin, M.D.A.
Agricultural Officer, Grade I. . .	..	G. J. Harvey, H.D.A.
Agricultural Officer, Grade I. . .	..	B. A. McBaron, Q.D.A.
Agricultural Officer, Grade I. . .	..	D. N. Brown, M.D.A.
Agricultural Officer, Grade I. . .	..	M. L. Jones, Q.D.A.

New Ireland District:

Agricultural Officer, Grade II. . .	..	P. D. Ramm, B.Sc.(Agr.) (W.A.)
Agricultural Officer, Grade I. . .	..	R. C. McDonald, B.Agr.Sc. (Qld.)
Agricultural Officer, Grade I. . .	..	S. S. Rigby, B.Agr.Sc. (Qld.)
Produce Inspector, Grade II. . .	..	C. A. Reason
Field Assistant	..	Tokau Komalu

DIVISION OF FISHERIES.**Headquarters:**

Chief of Division	A. M. Rapson, D.Sc. (N.Z.) . .	<i>Commercial marine products. Introduction of fresh water fishes</i>
Biologist, Grade III.	D. M. Dunstan, B.Sc. (Melb.) . .	<i>Estuarine fisheries, especially barramundi</i>
Biologist, Grade I.	M. Stuart Fox, B.Sc. (Qld.) . .	<i>Marine ecology, especially oysters</i>
Technical Assistant, Grade III.	J. A. Quinlan	<i>Inshore and estuarine fisheries</i>
Technical Assistant, Grade III.	R. F. Price	<i>F.R.V. Tagula</i>
Fishing Master Engineer	L. L. Shonhan	<i>Master, F.R.V. Tagula</i>
Typiste	Miss J. M. Herbert	

Western Highlands:

Biologist, Grade I.	R. S. Bucknell, B.Sc. (Qld.) . .	<i>Pond fisheries</i>
-----------------------------	----------------------------------	-----------------------

PAPERS PUBLISHED BY OFFICERS OF THE DEPARTMENT 1960-61.

- Anderson, J. L. (1960).—"Animal Health Picture of the Territory of Papua and New Guinea." *Papua and New Guinea agric. J.* **13**, (2): 52-65.
- Baseden, S. C. (1960).—"Notes on Deficiency Symptoms in Forestry Nurseries." *Papua and New Guinea agric. J.* **13**, (2): 76-77.
- Dunstan, D. J. (1961).—"Trolling Results of F.R.V. *Tagula* in Papuan Waters." *Papua and New Guinea agric. J.* **13**, (4): 148-156.
- Edward, I. L. (1960).—"Clonal Cacao at Keravat." *Papua and New Guinea agric. J.* **13**, (2): 43-51.
- Newton, K. (1960).—"Shifting Cultivation and Crop Rotations in the Tropics." *Papua and New Guinea agric. J.* **13**, (3): 81-118.
- Richardson, J. M. (1960).—"Herbicidal Control of Rain Forest Regrowth." *Papua and New Guinea agric. J.* **13**, (2): 66-69.
- Rothwell, T. L. W. (1960).—"Suspected Botulism in Poultry." *Papua and New Guinea agric. J.* **13**, (3): 125.
- Szent-Ivany, J. J. H. (1961).—"Insect Pests of *Theobroma cacao* in the Territory of Papua and New Guinea." *Papua and New Guinea agric. J.* **13**, (4): 127-147.
- Szent-Ivany, J. J. H., and Catley, A. C. (1960 (a)).—"Notes on the Distribution and Economic Importance of the Papuan Tip-Wilt Bug, *Amblypelta lutescens papuensis* Brown. (Heteroptera: Coreidae)." *Papua and New Guinea agric. J.* **13**, (2): 59-65.
- Szent-Ivany, J. J. H., and Catley, A. C. (1960 (b)).—"Observations on the Biology of the Black Leaf-footed Bug *Leptoglossus australis* (F.) (Heteroptera, Coreidae) in the Territory of Papua and New Guinea." *Papua and New Guinea agric. J.* **13**, (2): 70-75.
- Thrower, L. B. (1960).—"The Root-Knot Nematode." *Papua and New Guinea agric. J.* **13**, (3): 119-124.
- Van Velsen, R. J. (1961).—"Chlorotic Spot, a Virus Disease of *Passiflora foetida* in New Guinea." *Papua and New Guinea agric. J.* **13**, (4): 160-166.

OTHER PAPERS OF DIRECT RELEVANCE TO THE TERRITORY
PUBLISHED IN 1960-61.

- Booth, C., and Shaw, Dorothy E. (1961).—"Black Cross, Caused by a New Species of *Phyllacora* on Banana." *Papua and New Guinea agric. J.* **13**, (4): 157-159.
- Gordon, W. L. (1960).—"The Taxonomy and Habitats of *Fusarium* species from Tropical and Temperate Regions." *Can. J. Bot.* **38**: 643-658. Includes mention of *Fusarium oxysporum* and *F. solani* isolated from *Crotalaria anagyroides* in Papua and New Guinea and identified by Dr. Gordon.

